Boulder River Watershed
Total Maximum Daily Loads

Draft Public Review Document
Montana Department of Environmental Quality
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SECTION 1.0
EXECUTIVE SUMMARY

The Boulder River watershed is a forested drainage encompassing approximately 528 square miles. Half of the watershed's area lies within the Absaroka-Beartooth Wilderness. The Boulder River Watershed (also referred to in this document as the Boulder Total Maximum Daily Load Planning Area, or TPA) is one of more than 90 TMDL planning areas in the State of Montana in which water quality is currently or was previously listed as impaired. In each of these TMDL planning areas, the State of Montana is required to develop TMDLs to reduce pollutant loading and eliminate other negative impacts to water quality in impaired water bodies.

This document presents a review of data on streams identified previously as impaired, and presents TMDLs for verified impairments. This document focuses on sediment, nutrients and metals related water quality impairments in the Boulder TMDL Planning Area (TPA). The primary objective is to develop an approach to restore and maintain the physical, chemical, and biological integrity of streams in the sub-basin so they will support all uses identified in state water quality standards. The uses include drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Clean Water Act objectives include restoration and maintenance of these watershed attributes for all of these uses. The Clean Water Act also requires the development of TMDLs that, when implemented, will result in conditions that support all beneficial uses. Fishery and associated aquatic life, recreation or drinking water uses are usually the most sensitive uses in the Boulder watershed when developing TMDLs.

A TMDL is a pollutant budget identifying the maximum amount of a particular pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. Section 303 of the Federal Clean Water Act and the Montana Water Quality Act (Section 75-5-703) require development of TMDLs for impaired water bodies that do not meet Montana water quality standards. Section 303(d) also requires identification of impaired water bodies on a list, referred to as the 303(d) list. This 303(d) list is updated every two years and submitted to the U.S. Environmental Protection Agency (U.S. EPA) by the Montana Department of Environmental Quality (MDEQ).

The document structure provides specific sections that address TMDL components and watershed restoration. Sections 1.0 through 3.0 provide background information about the Boulder River watershed, Montana's water quality standards, and Montana's 303(d) listings. Section 4.0 provides a review of data for water body segments listed as impaired on the 2006 303(d) list, and Section 5.0 provides all necessary TMDLs for water bodies with verified impairments, and provides a framework restoration strategy for addressing known impairments.

Table E-1, provides a summary of how each of these waterbodies were addressed in this Water Quality Restoration Plan (WQRP). To help address any assumptions or uncertainties that arose, data gap, target compliance and implementation monitoring strategies are included within the document.

Table E-1. Summary of Required TMDL Elements for the Boulder River TMDL Planning Area

Waterbodies & Pollutants* of Concern	East Boulder River MT43B004_141	Sedimentation/Siltation Chlorophyll-a
	East Boulder River MT43B004_142	Chlorophyll-a
	Boulder River MT43B004_131	Copper Iron Lead Silver
	Boulder River MT43B004_132	Chromium Nickel Nitrate/Nitrite Total Kjeldahl Nitrogen
	Boulder River MT43B004_133	Phosphorous (Total) Nitrate/Nitrite Total Kjeldahl Nitrogen Excess Algal Growth
	Boulder River MT43B004_134	Copper Lead
Impaired Beneficial Uses*	East Boulder River MT43B004_141	Aquatic life Cold Water Fishery Contact Recreation
	East Boulder River MT43B004_142	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_131	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_132	Aquatic life Cold Water Fishery
	Boulder River MT43B004_133	Aquatic life Cold Water Fishery Contact Recreation
	Boulder River MT43B004_134	Aquatic life Cold Water Fishery Drinking Water
Pollutant Sources*	• Irrigated crop production • Impacts from abandoned mine lands • Flow Alterations from water diversions • Unknown sources	

Table E-1. Summary of Required TMDL Elements for the Boulder River TMDL Planning Area

Water Quality Targets	Sediment Targets • % surface fines < 2mm <10% • Macroinvertebrate populations acceptable per DEQ metrics. • Width to depth ratio target <36 for C3 streams in the watershed. Nutrient Targets • 0.08 mg/L for NO2+NO3 • 0.02 mg/L for total phosphorus • 0.38 mg/L for total nitrogen Metals Targets • Chronic aquatic life standards for metals
Required TMDLs	Sediment TMDLs are not required • East Boulder River segments MT43B004_141 and MT43B004_142 are meeting sediment water quality targets Nutrient TMDLs are not required • East Boulder River segments MT43B004_141 and MT43B004_142 are meeting nutrient targets • Boulder River nutrient impairments (segments MT43B004_132 and MT43B004_133) were not addressed in this document Metals TMDLs • The TMDL is an equation based on water hardness and stream flow
Allocations	Metals Load Allocation is 90% of the TMDL and is allocated to the cumulative load derived from naturally occurring sources and from historic mining activity and abandoned mines sources Total Metals Wasteload Allocation shall not exceed 10% of the TMDL • The wasteload allocation to individual permitted sources is based on the existing permitted design discharge of the facility, and either the acute or chronic (in the case of lead) standard. • A wasteload allocation to future permitted sources is also provided
Restoration Strategies	• Utilize state and federal programs in place to reclaim abandoned mines • Detailed surface water sampling plan to better quantify metals loading rates and mechanisms • Utilize an adaptive management approach in restoration activities

Table E-1. Summary of Required TMDL Elements for the Boulder River TMDL Planning Area

Margin of Safety	• The Margins of Safety for copper, lead, and iron are implicit because the analyses are conservative. • The chronic standards were used in calculating the restoration targets providing more protective targets as goals. • 25 mg/L hardness value was used in the target load calculations • An adaptive management approach will be used to implement reductions that work towards compliance with in stream standards.
Seasonal Considerations	• Metals targets and loads were calculated based on high flow, low hardness events, ensuring year-round compliance

** based on 2006 303(d) List. Verification of final impairment status*

SECTION 2.0
WATERSHED CHARACTERIZATION

2.1 Physical Characteristics

2.1.1 Location

The Boulder River watershed comprises approximately 528 square miles in Sweet Grass and Park counties in south-central Montana. Approximately one-half of the watershed lies within the Absaroka-Beartooth Wilderness Area (ABWA). The watershed drains the East Boulder, West Boulder, and Lake Plateaus, and drains headwater areas at an elevation of up to approximately 11,300 feet on Mount Douglas to the northeast down to the mouth at the Yellowstone at an elevation of approximately 4,000 feet.

The Boulder River Watershed comprises a portion of the Upper Yellowstone 4th field Hydrologic Unit Code sub-basin (HUC No. 10070002), and contains two 5th field watersheds (Figure 2-1):

- HUC 10070002090 Includes the West Boulder and Main Boulder below the mouth of the West Boulder River and associated tributaries, including:
  - Davis Creek
  - Falls Creek

- HUC 10070002080 Includes the East Boulder and the Main Boulder above its confluence with the West Boulder and associated tributaries, including:
  - Elk Creek
  - Dry Fork Creek
  - Brownlee Creek
  - Graham Creek
  - Great Falls Creek
  - Speculator Creek
  - Hawley Creek
  - Fourmile Creek
  - Meat Rack Creek
  - Bridge Creek
  - East Fork Boulder River
  - Rainbow Creek

2.1.2 Topography

Figure 2-1 shows the general topography of the Boulder River Watershed. The southern portion of the watershed is typically steep mountainous and heavily forested terrain, and lies within the ABWA at elevations above 5,000 feet. The northern portion of the watershed, below the National Forest Boundaries is primarily wider, flatter alluvial valleys and foothills.

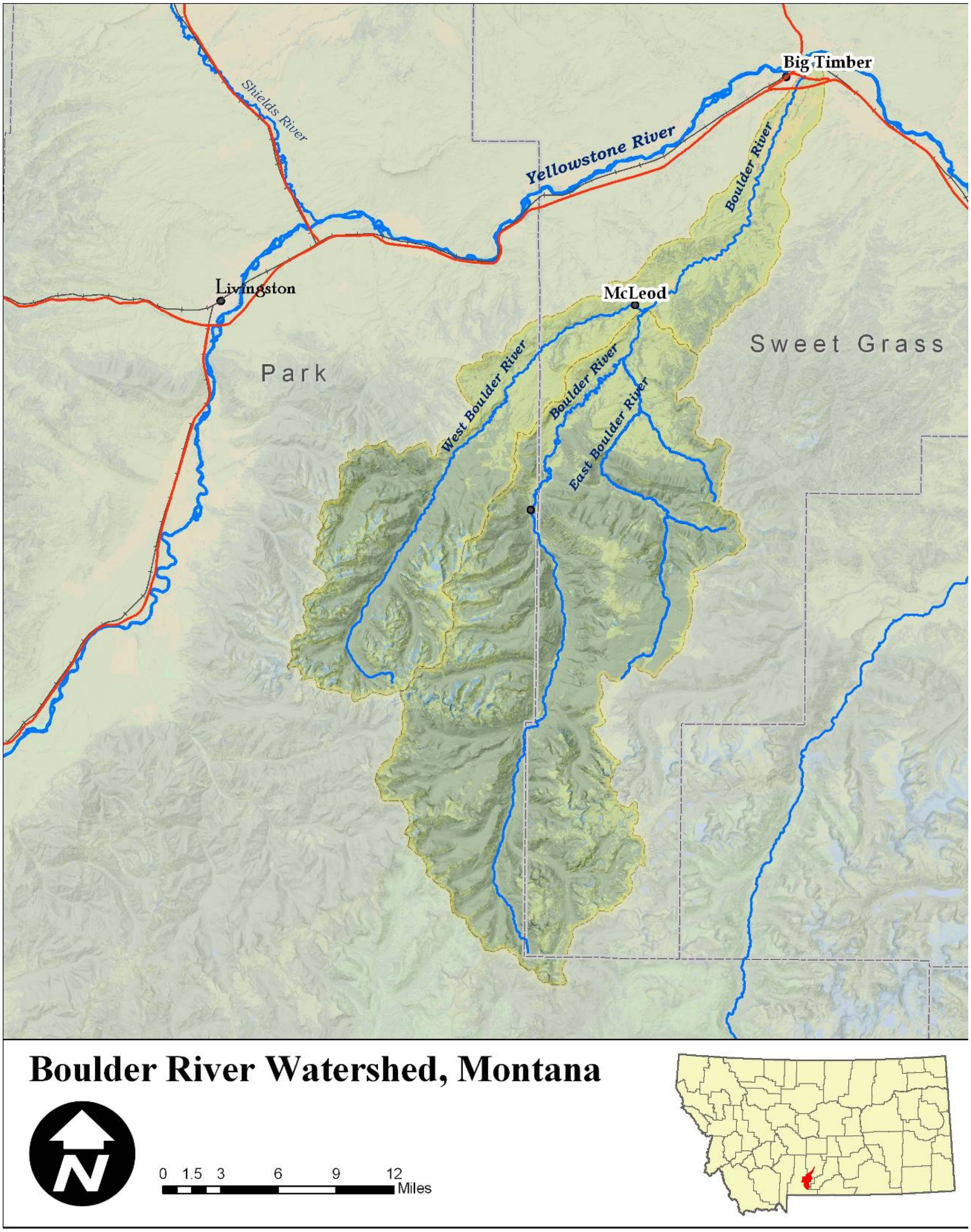

Figure 2-1. Boulder River watershed overview map

2.1.3 Climate

The Western Regional Climate Center provides data for several weather stations in Montana, including data collected from 1894 to 2003 in Big Timber, Montana. Figure 2-2, shows average minimum and maximum air temperatures and temperature extremes for Big Timber. In general, average daytime high temperatures range from the lower 30's in January and February to the 80's in late July. Average low temperatures range from the teens in the winter to the 50's in July.

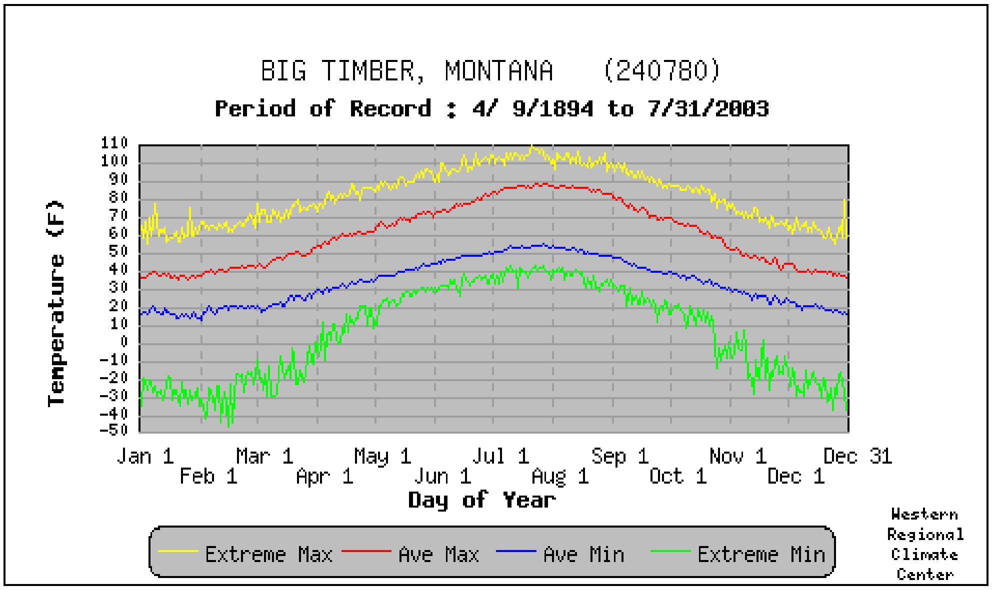

Figure 2-2. Minimum and maximum temperatures, Big Timber, Montana

Precipitation data is also summarized by the Western Regional Climate Center for Big Timber. Figure 2-3 shows average monthly precipitation (in inches) for Big Timber from 1961-1990. The lower elevation Boulder River corridor receives approximately 15 inches of precipitation per year, while the headwaters for the Boulder River watershed generally receive 40 to 55 inches of annual precipitation.

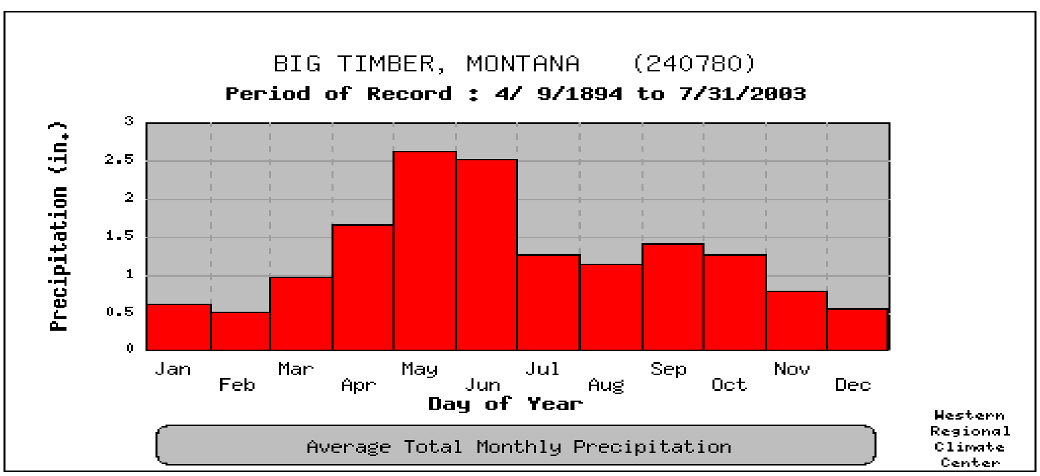

Figure 2-3. Average monthly precipitation, Big Timber, Montana

The National Oceanic and Atmospheric Administration (NOAA) collects data from three Snowpack Telemetry (SNOTEL) Stations located within the Boulder watershed. These SNOTEL stations are:

- Box Canyon, at an elevation of 6,699 feet
- Monument Peak, at an elevation of 8,852 feet
- Placer Basin, at an elevation of 8,829 feet

These stations are maintained and monitored by the Natural Resources Conservation Service (NRCS). Average annual precipitation at the Placer Basin site over the past 30 years is approximately 40 inches (including snow-water-equivalent values).

2.1.4 Hydrology

The United States Geologic Survey (USGS) National Water Information System (NWIS) online database lists five historical surface water flow gages and one current surface water flow gage in the Boulder watershed. Three of these stations occur on the main stem of the Boulder:

- USGS 06197500: Boulder River near Contact, Montana (historic site)
- USGS 06199500: Boulder River near McLeod, Montana (historic site)
- USGS 06200000: Boulder River at Big Timber, Montana (current site)

Two historic sites were located on the West Boulder River:

- USGS 06198500: West Fork Boulder River near Bruffeys, Montana
- USGS 06199000: West Boulder River at McLeod, Montana

One historic site was located on the East Boulder:

- USGS 06198000: East Boulder River near McLeod

Figure 2-4 shows flows for station USGS 06200000 for the Boulder River at Big Timber from 1947 through 2001.

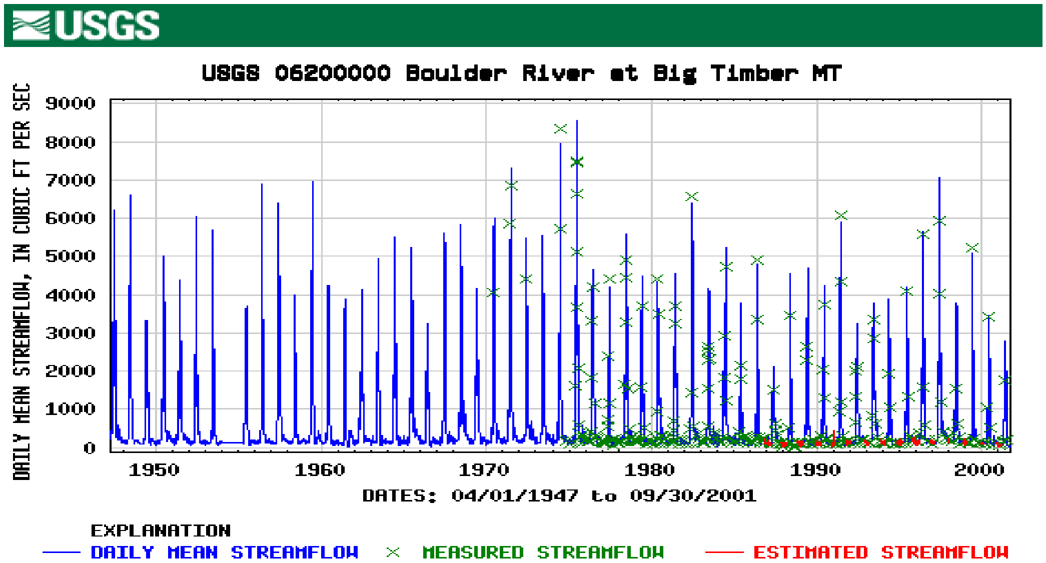

Figure 2-4. Historic flow data for Boulder River at Big Timber, Montana

Figure 2-5 shows a typical seasonal hydrograph for station USGS 06200000 compiled from average daily flows for a 54 year period of record from 1947 through 2001. Both the rising and falling limbs of the hydrograph are very steep, showing that runoff events in the Spring are intense, and irrigation withdrawals and diminishing snowpacks in early summer cause steep reductions in flow.

Peak flows are typically in late May in response to rainfall and snowmelt events and average about 3,000 cubic feet per second. Flows diminish sharply through June and July in response to diminished snow pack and extensive irrigation uptakes upstream of Big Timber. By mid-July, base flows of approximately 200 cubic feet per second (cfs) are reached, with little change until the following spring’s runoff.

Streamflow data has been collected in the watershed by USGS at various sites since the early 1900’s. The longest running and most current data has been collected at the USGS site located near Big Timber (USGS Site 06200000). Data were available for this site from the USGS WATSTORE database for streamflow data collected from 1947 through 2001.

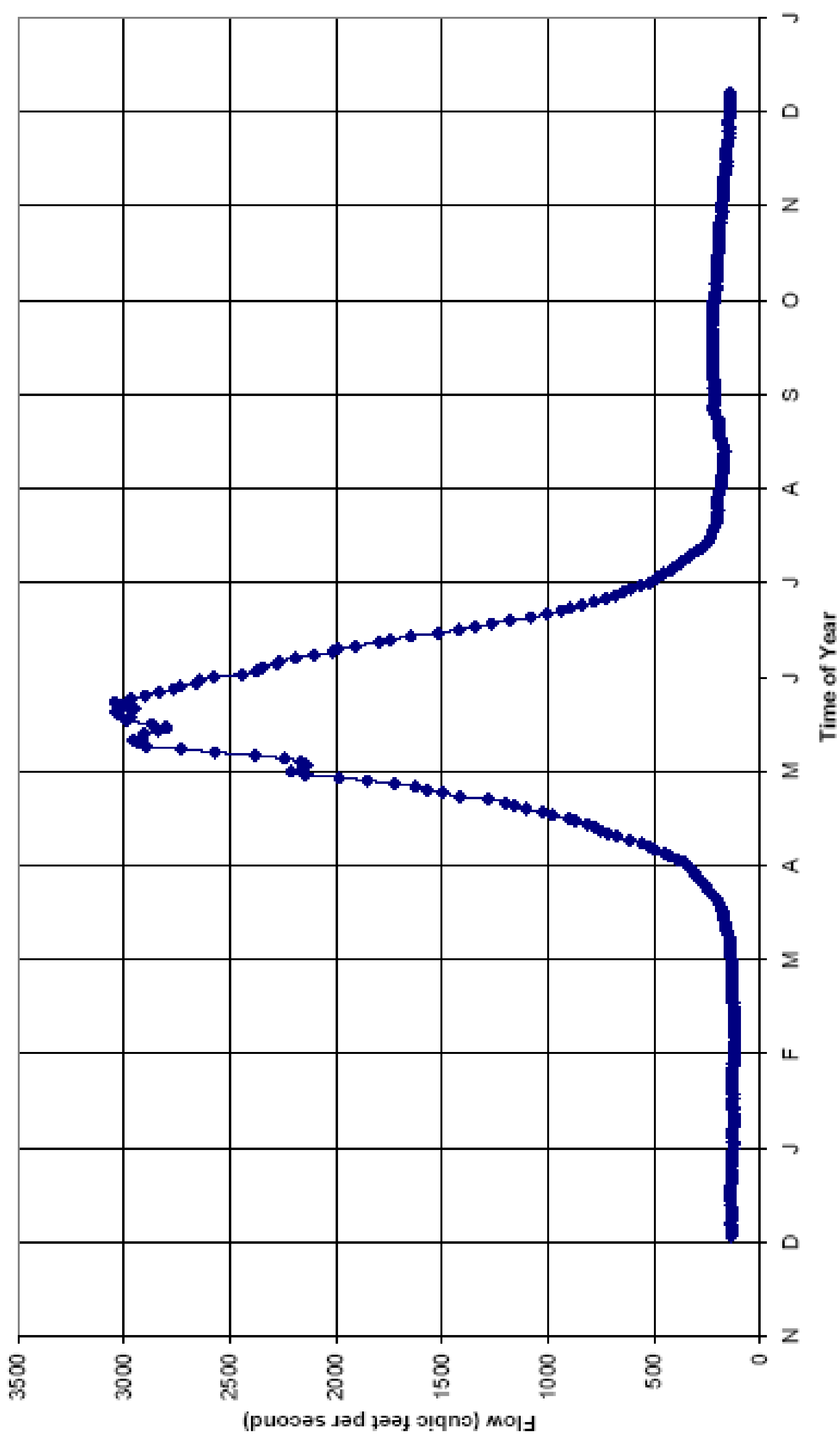

Figure 2-5. Typical hydrograph - Boulder River at Big Timber based on average daily flows 1947 - 2001

Minimum discharges usually occur during late summer when irrigation diversion is greatest. More recent data indicate the present drought in Montana. In 1999, discharge was very similar to average, with slightly below average flows in the late summer and early fall of that year. However, in 2000 and particularly in 2001, stream flow as measured at Big Timber was well below average for the Boulder River. Peak flows reached only 2,181 and 1,484 cfs in 2000 and 2001 respectively, and streamflow dropped as low as 25.5 cfs in August 2001 (DeArment 2003).

2.1.5 Geology

USGS geologic mapping shows the primary geology within the Boulder River Watershed (Figure 2-6). Uplifted Precambrian gneiss and schist comprise the upper watershed, and Paleozoic sedimentary rocks dominate the lower reaches below Contact. Tertiary volcanoclastics cap the Precambrian rock in the extreme upper watershed, and unconsolidated glacial deposits and alluvium drape lower portions of the watershed.

Abandoned mines are located throughout the watershed (Figure 2-7). Three Priority Abandoned Mine sites are located in the Independence Mining District in the Basin Creek drainage; the Poorman/Emma Mine, the Yager/Daisy Mine and a mine identified as NW SE Section 22 Mine.

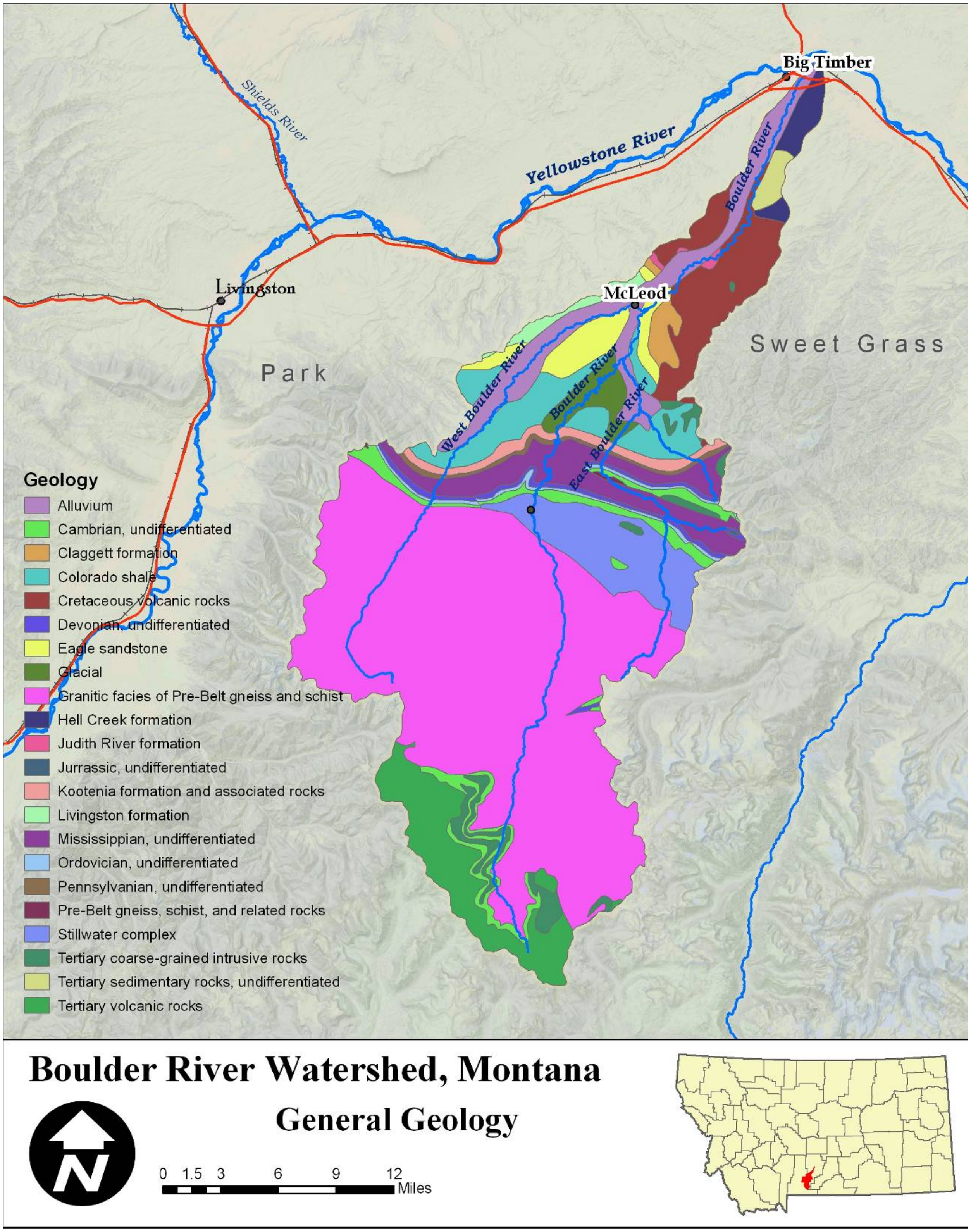

Figure 2-6. Boulder River watershed general geology map

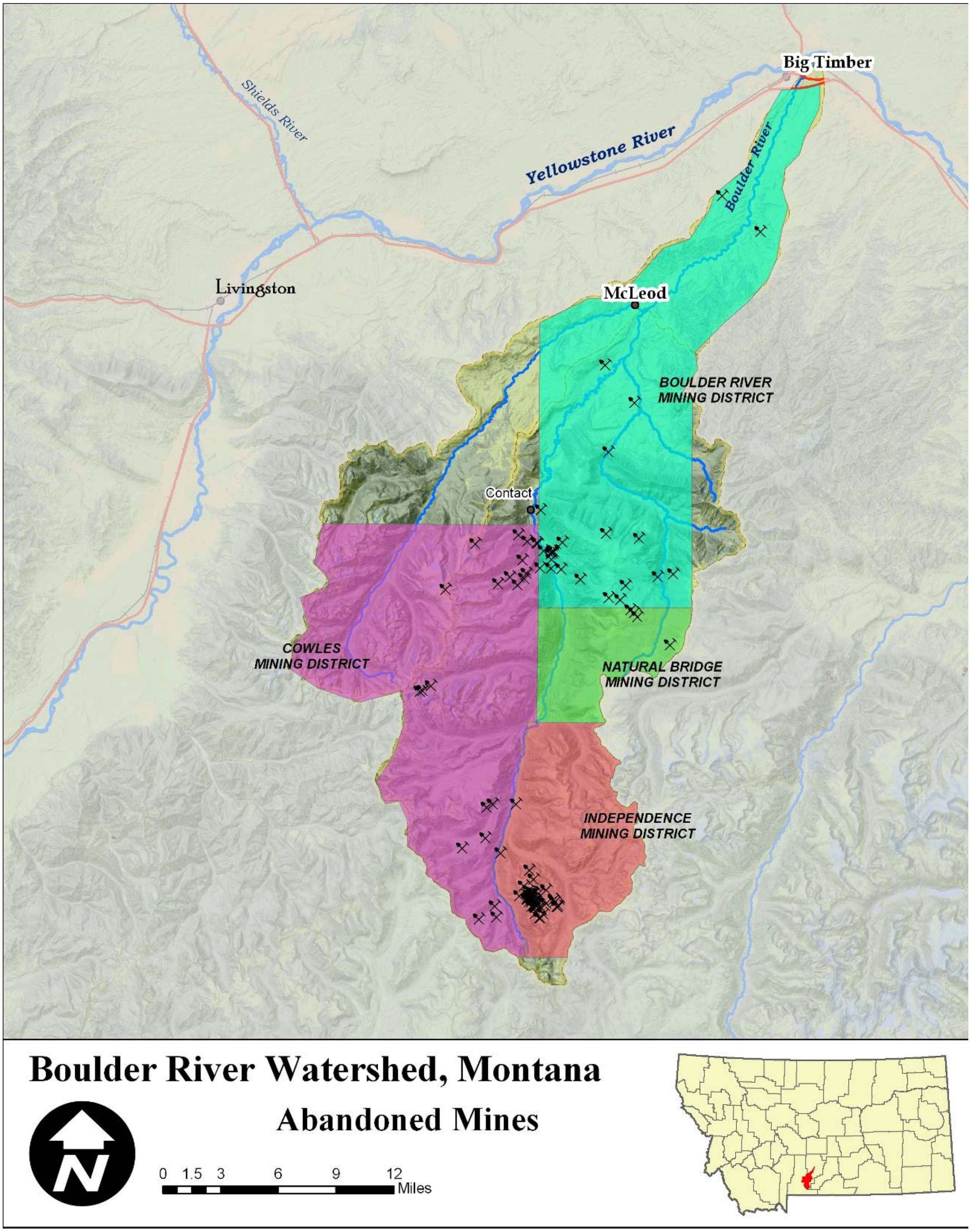

Figure 2-7. Boulder River watershed historic mining map

2.1.6 Soils

Fourteen NRCS soil mapping units occur within the Boulder River Watershed (Figure 2-8 and Table 2-1). Soils of the upper watershed are predominantly outcrops and shallow soils derived of calcarious and non-calcarious decomposed rock, and conifer detritus, while lower watershed soils are typically deeper loamy alluvial soils.

Table 2-1. NRCS soil mapping units in the Boulder River watershed

NRCS Soil Mapping Unit	Acres	% of Area
Shadow-Garlet-Macfarlane	95,069	28.1
Rock Outcrop-Rubble Land-Cowood	72,627	21.5
Absarokee-Hilger-Big Timber	37,687	11.2
Prospect-Sublette-Teton	25,645	7.6
Shadow-Comad-Rock Outcrop	17,013	5.0
Havre-Ryell-Harlem	16,489	4.9
Shadow-Garlet-Water	15,079	4.5
Whitefish-Gallatin-Helmville	14,539	4.3
Rock Outcrop-Water-Rubble Land	13,541	4.0
Helmville-Whitore-Tropal	11,329	3.4
Sweetgrass-Hilger-Fairfield	8,254	2.4
Mirror-Bross-Vasquez	5,861	1.7
Tigeron-Garlet-Worock	4,032	1.2
Worock-Garlet-Rock Outcrop	733	0.2
TOTAL	337,898	100.0

Soils across the planning area vary with local geology, topographic relief, and climate (United States Department of the Interior 2003). Soils on flood plains and terraces are more than 60 inches deep and formed in loamy material deposited by water. All other soils vary in depth from less then 20 inches to more then 60 inches. Soils on lower elevations uplands and terraces were transported by wind or water or were formed from igneous and metamorphic rocks. Soils on the higher elevation uplands form in water deposited materials or from metamorphic rock. Soils on mountains are formed mainly from glacial till or bedrock.

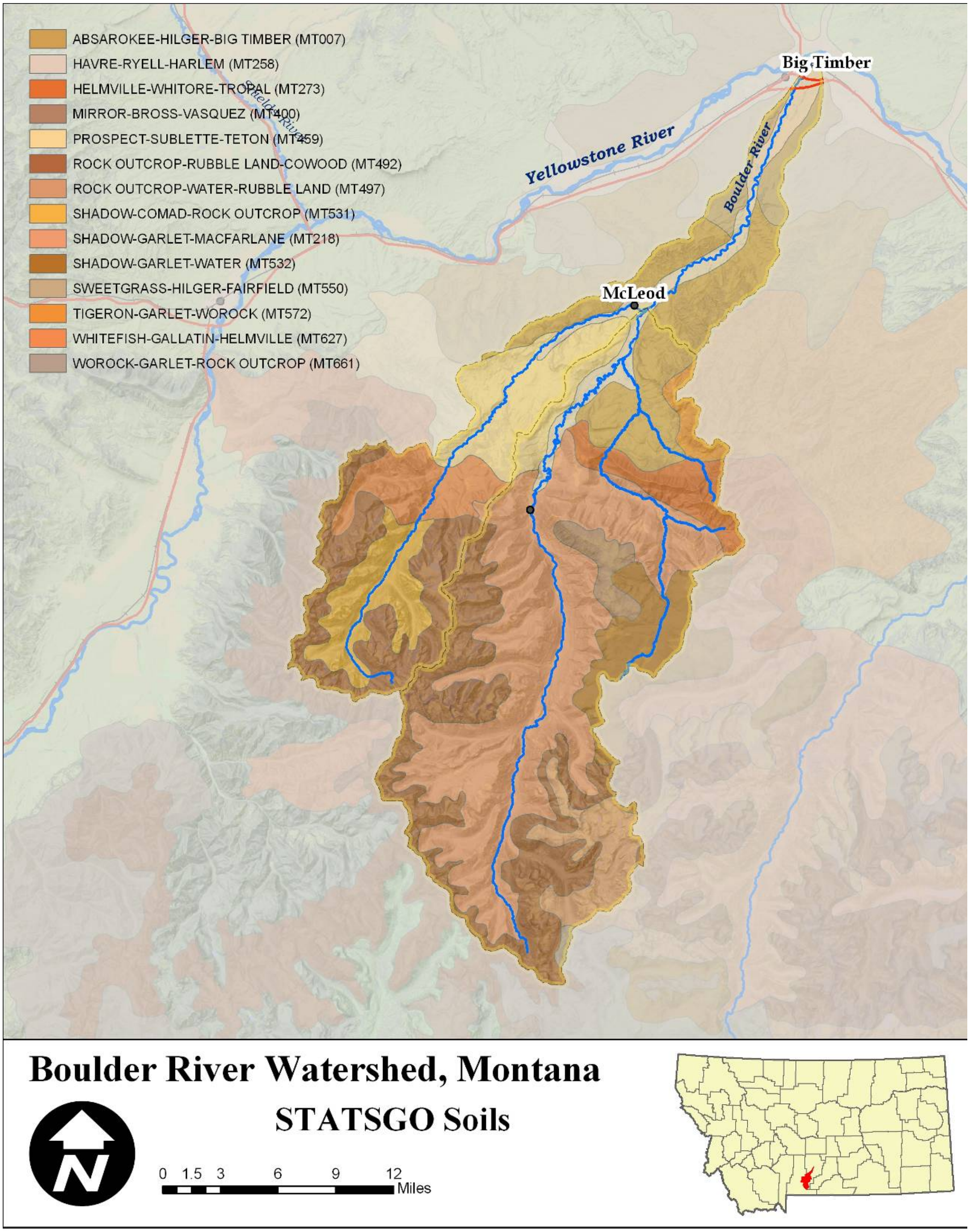

Figure 2-8. Boulder River watershed STATSGO soils map

2.1.7 Land Use and Land Cover

A simplified vegetation cover in the watershed is shown in Figure 2-9 and is dominated by alpine forest and grasslands. In general, coniferous trees dominate the plant communities upstream of Natural Bridge, while grasslands dominate below.

Several noxious weeds have been identified in the watershed and are a threat to streambank stability when they transplant native riparian vegetation. Spotted knapweed, sulfur cinquefoil, and leafy spurge have been observed..

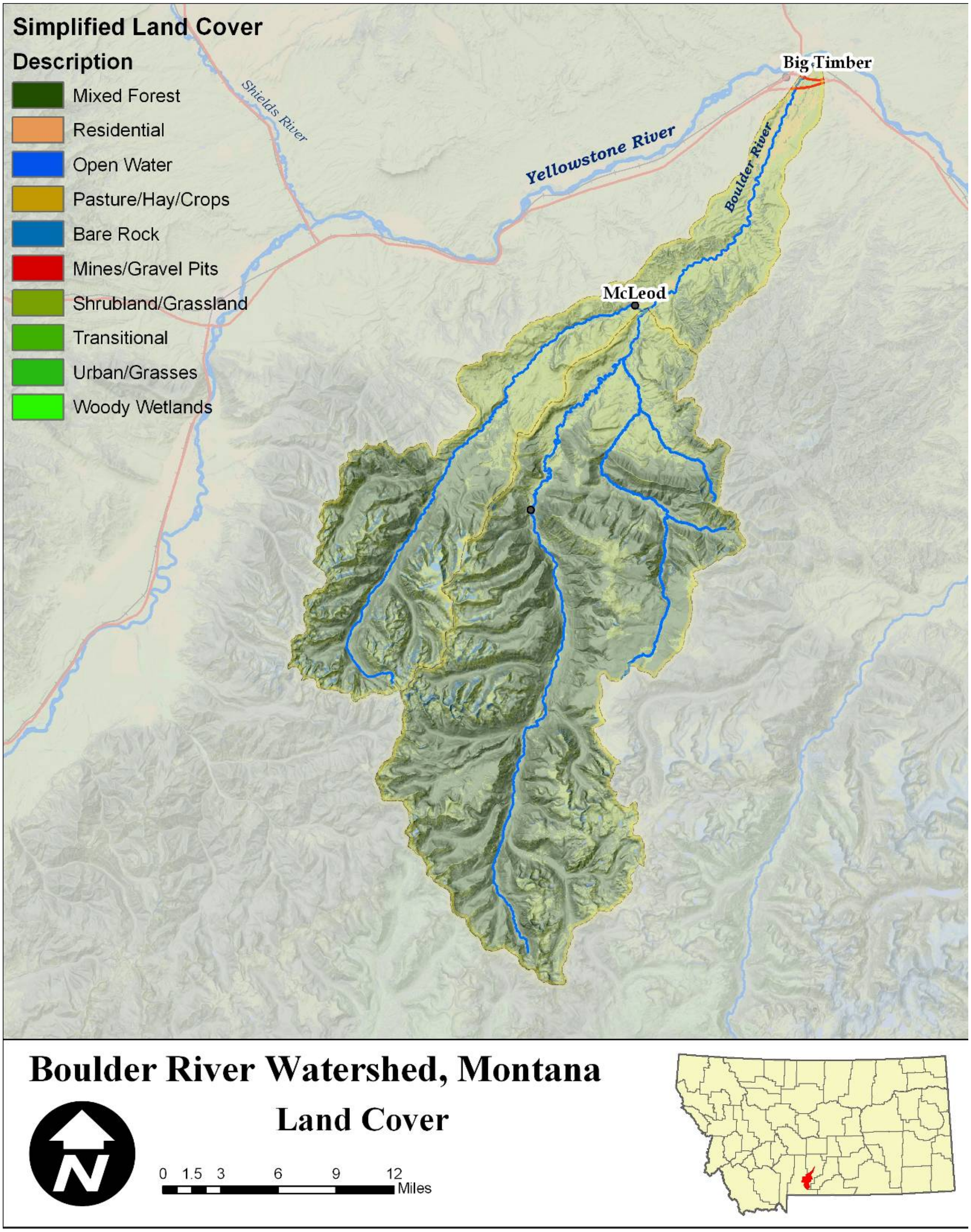

Figure 2-9. Boulder River watershed land cover/land use map

2.2 Cultural Characteristics

2.2.1 Population

Population statistics for the Boulder River watershed were compiled from the NRIS database. Population data are from the 1990 and 2000 United States Census Data. Based on the referenced sources, 1857 people lived within the Boulder River watershed in 1990. In 2000, a population of 1832 people was reported showing a slight decline in population.

Big Timber, the largest town in the watershed, has a population of approximately 1650 residents, not all of which reside within the Boulder River watershed. Most of the rural residents in the watershed live in the northern portion of the area and are involved in agriculture. The southern portion of the watershed is primarily United States Forest Service (USFS) Lands within the ABWA.

2.2.2 Land Ownership

Land ownership information was compiled from the NRIS database, and the Montana Cadastral Mapping Project database. Ownership, by category, is shown in Figure 2-10 and displayed ion Figure 2-11. The USFS is by far the largest landowner in the Boulder River watershed, holding a total of approximately 388 square miles of the watershed, or approximately 74%. Bureau of Land Management (BLM) holds about 4.4 square miles (less than 1%), the State of Montana holds about 9.5 square miles (less than 2%), with the remaining 122 square miles (23%) privately owned.

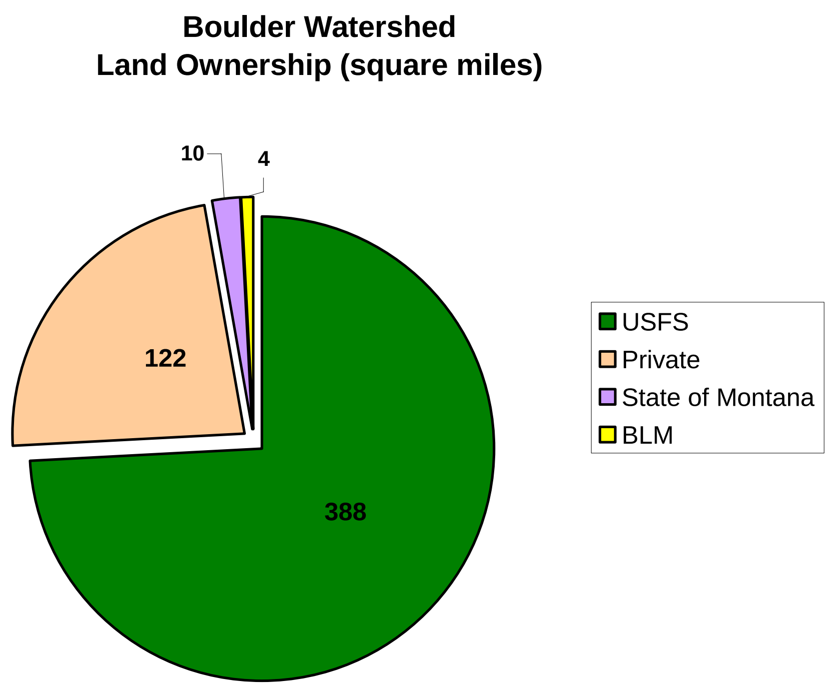

Figure 2-10. Land ownership in the Boulder Watershed

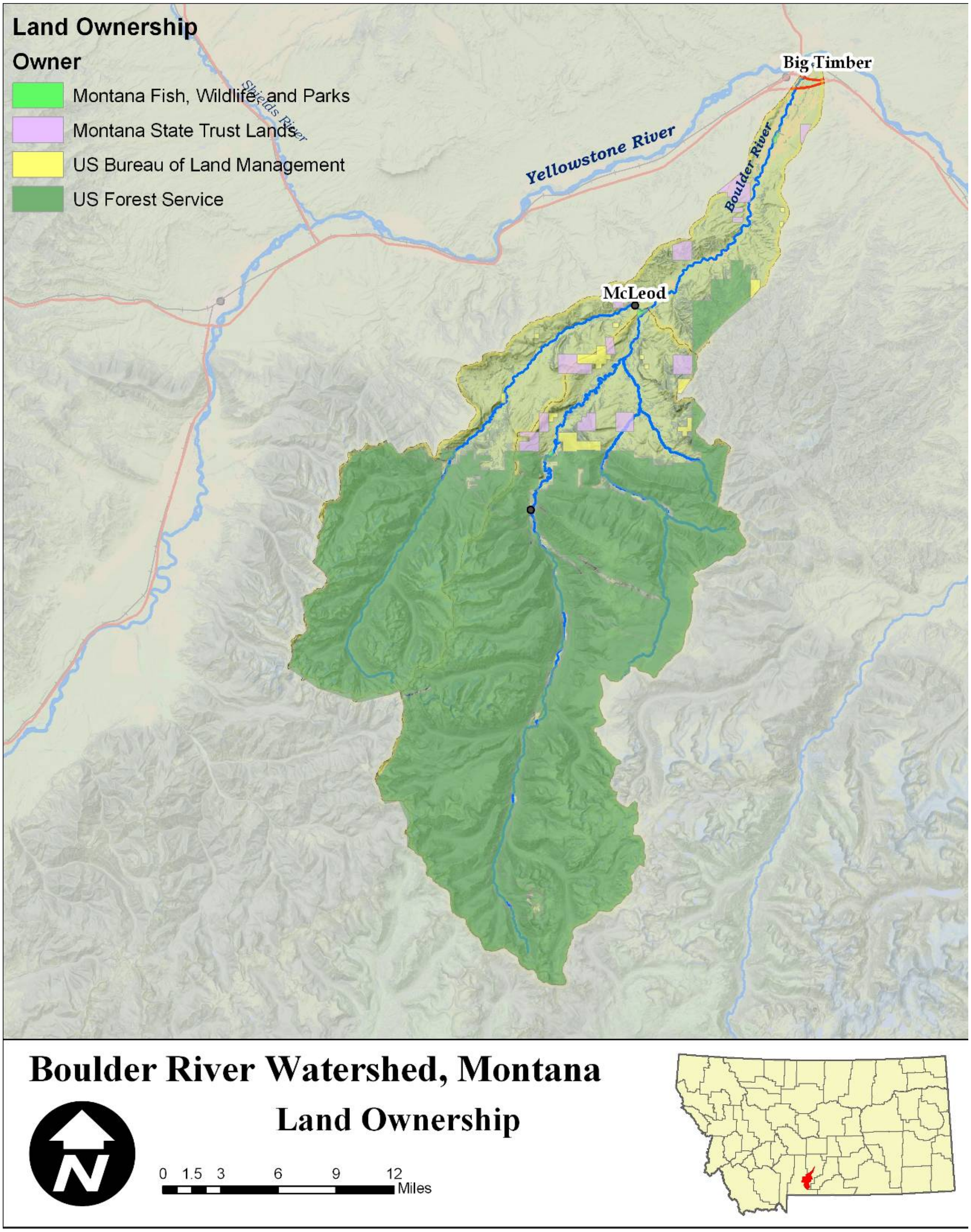

Figure 2.11. Boulder River watershed land ownership map

2.2.3 Recreation

As reported by the Statewide Comprehensive Outdoor Recreation Plan (SCORP) task force, tourism is the second largest industry behind agriculture in Montana. Outdoor recreation made up 75 % of the activities reported by non-resident travelers to Montana from 2000 to 2001 (FWP 2003a). Popular recreational activities within the Boulder River wateshed include hunting, fishing, golf, camping, hiking, horseback riding, bicycling, rafting, and skiing among others. Coldwater fisheries are an important feature of the recreation in the Boulder River Watershed.

Montana Department of Fish, Wildlife and Parks (MFWP), considers the Boulder River and its tributaries to provide excellent opportunities for wild trout fishing and other year around opportunities (ECON, 1993), and has designated most of the mainstem of the Boulder a blue-ribbon or Class 1 fishery (FWP website). Anglers and other recreational users have considerable access to the Upper Boulder and East Boulder Rivers, primarily at fishing access sites, campgrounds, and within Forest Service boundaries. The West Boulder and Lower Boulder are less accessible due to extensive private ownership along the streams.

2.3 Biological Resources

Nearly half of the Boulder River watershed is included in the ABWA, which borders Yellowstone National Park to the south. This area contains some of the most unique and pristine alpine habitat in the world and is home to a diverse and ecologically unique population of wildlife. The biological resources of the area are a major draw for area residents as well as tourists. Biological resources include the cold-water fisheries, big-game and rare large mammals, upland game birds, waterfowl, raptors and songbirds, fur-bearers, as well as other numerous small mammals and rodents.

2.3.1 Fisheries

The Montana Fisheries Information System (MFISH) contains information on fish species in Montana's rivers. Fish species found in the Boulder River and its tributaries, relative abundance, and stream reaches in which they occur are shown in Table 2-2. Abundance estimates range from abundant to common to rare.

Table 2-2. Fish species, location, and relative abundance

Species	Stream reach in river miles from the mouth of stream	Abundance
Main Boulder		
Brook Trout	37.2 to 42.2 42.2 to 47.6	Abundant Rare
Brown Trout	0 to 37.2	Abundant
Longnose Dace	0 to 22.9	Common
Longnose Sucker	0 to 37.2	Abundant

Table 2-2. Fish species, location, and relative abundance

Species	Stream reach in river miles from the mouth of stream	Abundance
Mottled Sculpin	0 to 22.9	Common
Mountain Sucker	0 to 22.9	Common
Mountain Whitefish	0 to 37.2	Abundant
Rainbow Trout	0 to 50.1 51.9 to 56.2	Common Rare
Yellowstone Cutthroat Trout	52.2 to 65.2 0 to 11.3 East Fork of Main Boulder	Rare Abundant
East Boulder River		
Brook Trout	0 to 6.1	Rare
Brown Trout	0 to 12.2 12.2 to 15.7	Common Rare
Longnose Dace	0 to 3.1	Rare
Mottled Sculpin	0 to 6.1	Abundant
Mountain Sucker	0 to 3.1	Rare
Mountain Whitefish	0 to 3.1	Rare
Rainbow Trout	0 to 12.2 12.2 to 13.6 13.6 to 15.7	Abundant Common Rare
Yellowstone Cutthroat Trout	15.6 to 22.8	Abundant Common
West Boulder River		
Brown Trout	0 to 24.1	Common
Longnose Dace	0 to 16.9	Rare
Longnose Sucker	0 to 16.9	Common
Mottled Sculpin	0 to 16.9	Rare
Mountain Whitefish	0 to 24.1	Common
Rainbow/Cutthroat Hybrid	0 to 24.1	Rare
Yellowstone Cutthroat Trout	16.9 to 25	Common

The Dewatered Streams List was compiled by the FWP in 1991 to identify streams that have had a periodic or chronic reduction in streamflow to a point that leads to unsuitable stream habitat for fish. Chronic dewatering refers to streams that are dewatered in virtually all years, and periodic dewatering refers to streams that are dewatered in drought or water-short years. Within the Boulder River watershed, chronic dewatering has been reported (in the MFISH database) for the lowest 5 miles of Boulder River.

2.3.2 Threatened and Endangered Species

The Montana Natural Heritage Program (MNHP) compiles information on species that are endangered or threatened in Montana. Nearly half of the watershed is a designated wilderness area which borders Yellowstone National Park to the south. A diverse population of species inhabits this pristine area, often with healthy populations found in few other places. MNHP-listed species for Sweetgrass and Park Counties include listed threatened species such as the bald eagle, the grizzly bear and the Canada lynx. The black-footed ferret is a listed endangered species, while the black-tailed prairie dog is a candidate for threatened or endangered status. MNHP also list the gray wolf as a non-essential experimental population in the area.

SECTION 3.0
TMDL REGULATORY FRAMEWORK AND WATER QUALITY STANDARDS

Section 3 presents the status of all 303(d) listed water bodies in the Boulder Watershed TMDL Planning Area (i.e., which water bodies are listed as impaired or threatened and for which pollutants). This is followed by a summary of the applicable water quality standards.

Section 4 presents a review and analysis of available water quality data, an updated water quality impairment status determination for each listed water body, and a determination of whether development of TMDLs is necessary.

3.1 TMDL Regulatory Requirements

Section 303(d) of the Federal Clean Water Act (CWA) requires states to identify water bodies within its boundaries that do not meet state water quality standards. States track these impaired or threatened water bodies through the 303(d) list, a component of Montana's Water Quality Integrated Report. State law identifies that a methodology for determining the impairment status of each water body is used for consistency and the actual methodology is identified in Appendix A of Montana's Water Quality Integrated Report.

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data show that the water body or stream segment is failing to achieve compliance with applicable water quality standards (Montana Water Quality Act; Section 75-5-103(11)). A "threatened water body" is defined as a water body or stream segment for which sufficient credible data and calculated increases in loads show that the water body or stream segment is fully supporting its designated uses but threatened for a particular designated use because of: (a) proposed sources that are not subject to pollution prevention or control actions required by a discharge permit, the nondegradation provisions, or reasonable land, soil, and water conservation practices; or (b) documented adverse pollution trends (Montana Water Quality Act; Section 75-5-103(31)). **State Law and section 303 of the CWA require states to develop all necessary TMDLs for impaired or threatened water bodies.**

TMDLs are developed for pollutants: these are water quality impairments that can be quantified and a load can be calculated. Riparian degradation and habitat alteration are not pollutants but are considered pollution-related impairments, and thereby do not require TMDLs. Additionally, flow alteration and dewatering are impairment issues related to water quantity and when viewed alone are not subject to a TMDL. However, sediment-related impairments may be related to stream energy and flow conditions. Likewise, riparian degradation and habitat alteration, when considered alone do not require a TMDL, yet are often linked to pollutant loading and may exacerbate and contribute to the loading and influence of a pollutant in a stream. As such, flow and habitat conditions are often considered when conducting TMDL analysis.

A TMDL is a pollutant budget for a water body identifying the maximum amount of the pollutant that a water body can assimilate without causing applicable water quality standards to be exceeded. TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources in addition to natural background sources, and must incorporate a margin of safety and consider influences of seasonality on analysis and compliance with water quality standards.

To satisfy the Federal Clean Water Act and Montana State Law, Total Maximum Daily Loads are developed for each **water body-pollutant combination** identified on the state's list of impaired or threatened waters (303(d) list). State Law (Administrative Rules of Montana 75-5-703(8)) also directs MDEQ to "support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for water bodies that are subject to a TMDL ……" This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing Federal, State, or Local regulations.

3.2 Water Bodies and Pollutants of Concern

The assessment of streams, lakes and wetlands to identify impaired waters for inclusion on Montana's Water Quality Integrated Report (IR) is an important step in a process intended to ensure that all water bodies in the state will have water quality adequate to support all of their classified beneficial uses. The process has been developed and shaped by legal mandates, water quality standards, the tools and techniques of water quality monitoring, the availability of information, and the funds and administrative resources that can be devoted to assessment efforts.

The impairment causes and sources determination included on the 1996 303(d) list was based on data that showed impairments, however many determinations were based on professional judgment and involved limited data. Since the development of the 1996 303(d) list, the Montana Department of Environmental Quality has instituted procedures that more fully assess and identify impaired waters. This procedure, the Sufficient Credible Data Assessment & Beneficial Use-Support Determinations (SCD/BUD) Process, conducted by the Montana Department of Environmental Quality in response to legal requirements stipulated in 75-5-702, MCA, resulted in updates to the 1996 303(d) listing. Consequently, impaired uses, causes, and sources on the 2006 303(d) list may differ from the original 1996 listings as a result of the data review and associated list revisions.

While the 2006 303(d) list is now Montana's most current list, and is based on more thorough data review and analysis than the 1996 list, a ruling by the U.S. District Court (CV97-35-M-DWM) on September 21, 2000 required that the State of Montana must complete all necessary TMDLs for waters listed as impaired or threatened on the 1996 303(d) list. Where new data has resulted in changes to the 303(d) listing status for 1996-listed waters through the State's SCD/BUD process, the DEQ will complete TMDLs based on updated impairments status resulting from this new information.

Water bodies reviewed by the State's SCD/BUD process fall into 5 categories. The level of beneficial use support for the listed waters can be as fully supporting all designated beneficial uses (F), threatened (T), partially support (P), not supporting (N) and lacking sufficient credible data (X). The Beneficial Use-Support Determination for the 303(d) listed streams in the Boulder River TMDL Planning Area is provided in Table 3-1. A map of segment locations is given in Figure 3-1.

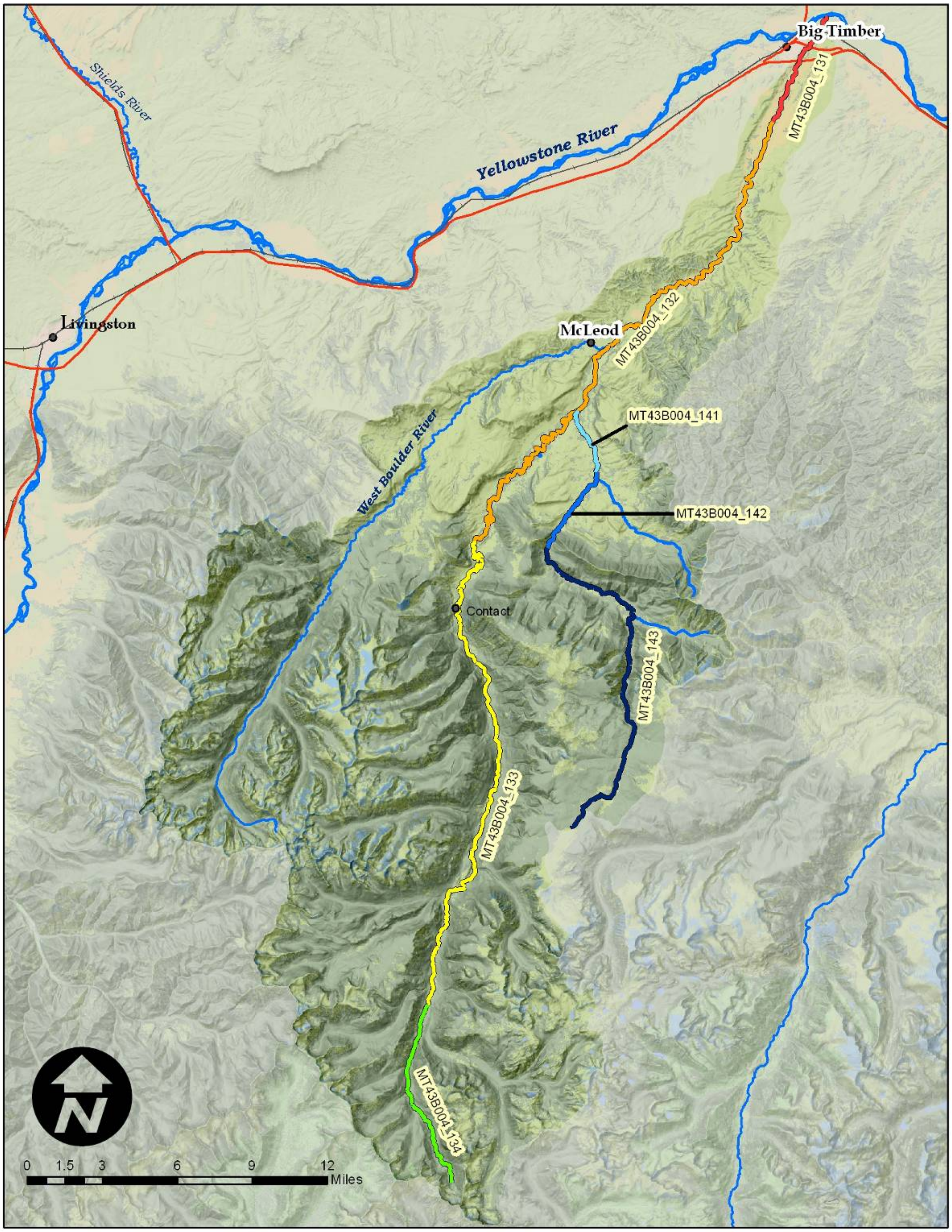

Figure 3-1. Water body segments in the Boulder TMDL Planning Area

Table 3-1. Impaired uses from both 1996 and 2006 303(d) lists. Source: DEQ, 1996, 2006

	1996 Use-Support							2006 Use Support						
Stream Reach (MT Water body ID)	**Use Classification**	**Aquatic Life**	**Cold Water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**	**Use Classification**	**Aquatic Life**	**Cold Water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**
East Boulder River (from Elk Cr to the mouth) MT43B004_141	B-1	T						B-1	P	P	F	F	F	P
East Boulder River (from National Forest boundary to Elk Cr) MT43B004_142	B-1	T						B-1	P	P	X	F	F	P
East Boulder River (from National Forest Boundary to headwaters) MT43B004_143	B-1	T						B-1	F	F	F	F	F	F
Boulder River (from the mouth to five miles upstream) MT43B004_131	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	P
Boulder River (from 5 miles upstream of the mouth to the National Forest boundary) MT43B004_132	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	F
Boulder River (from the National Forest boundary to the East Fork Boulder River confluence) MT43B004_133	B-1	X	X	X	X	X	X	B-1	P	P	F	F	F	P

Table 3-1. Impaired uses from both 1996 and 2006 303(d) lists. Source: DEQ, 1996, 2006

	1996 Use-Support							2006 Use Support						
Stream Reach (MT Water body ID)	**Use Classification**	**Aquatic Life**	**Cold Water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**	**Use Classification**	**Aquatic Life**	**Cold Water Fishery**	**Drinking Water**	**Agriculture**	**Industry**	**Contact Recreation**
Boulder River (from the East Fork Boulder River to the headwaters) MT43B004_134	B-1	X	X	X	X	X	X	B-1	P	P	N	F	F	F

One water body in the Boulder River TMDL Planning area occurs on Montana's 1996 303(d) list: East Boulder River (entire reach). The cause and source of impairment for the 1996 303(d) list is shown in Table 3-2. The 2006 303(d) list is summarized in Table 3-3.

Table 3-2. 1996 303(d) list information for the Boulder River TMDL Planning Area. Source: DEQ, 1996.

Segment Name (MT Water body ID)	Length (miles)	Probable Cause	Probable Source
East Boulder River MT43B004_141 MT43B004_142 MT43B004_143	23	**Nutrients**	Resource Extraction

Table 3-3. 2006 303(d) list information for the Boulder River TMDL Planning Area. Source: DEQ 2006.

Segment Name (MT Water body ID)	Length (miles)	Probable Cause	Probable Source
East Boulder River MT43B004_141	3.1	**Sedimentation/Siltation** Low flow alteration Other anthropogenic substrate alterations **Chlorophyll-a**	Flow Alterations from water diversions Streambank modifications/destabilization Source unknown
East Boulder River MT43B004_142	3	**Chlorophyll-a** Low flow alteration	Source unknown Agriculture
East Boulder River MT43B004_143	16.6	NA	NA

Table 3-3. 2006 303(d) list information for the Boulder River TMDL Planning Area. Source: DEQ 2006.

Segment Name (MT Water body ID)	Length (miles)	Probable Cause	Probable Source
Boulder River MT43B004_131	5	**Copper** **Iron** **Lead** **Silver** Low flow alterations	Impacts from abandoned mine lands Irrigated crop production
Boulder River MT43B004_132	27.8	**Chromium** **Nickel** **Nitrate/Nitrite** **Total Kjeldahl Nitrogen** Alteration of vegetative covers	Agriculture Grazing in riparian zones Source unknown
Boulder River MT43B004_133	23.5	**Phosphorous (Total)** **Nitrate/Nitrite** **Total Kjeldahl Nitrogen** **Excess Algal Growth**	Source Unknown
Boulder River MT43B004_134	8.2	**Copper** **Lead**	Impacts from abandoned mine lands

Pollutants of concern (in **bold, Table 3-3**), i.e. those requiring TMDL evaluation include:

- **Nutrients**
  Nutrients describe a suite of pollutants that contribute to excessive chlorophyll-a (algae) growth. These typically include organic and inorganic forms of phosphorous and nitrogen. Presently listed nutrient impairment causes in the Boulder TPA include chlorophyll-a, excess algal growth, total phosphorous, nitrate/nitrite, and total Kjeldahl nitrogen.
- **Metals**
  Metals include a variety of forms (dissolved and total recoverable) and can be evaluated as forms present in both water and sediment samples. Presently listed metals impairment causes in the Boulder TPA include copper, iron, lead, silver, chromium, and nickel.
- **Sediment**
  Sediment-related impairments relate to excessive sediment deposited on stream bottoms and in the water column. Presently listed sediment impairment causes in the Boulder TPA include sedimentation and siltation.

Specific information regarding the status of these pollutants is given in Section 4.

3.3 Applicable Water Quality Standards

Water quality standards include the uses designated for a water body, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the existing high quality of a water body. The ultimate goal of this TMDL plan, once implemented, is to ensure that water quality standards are met for all pollutants of concern identified on the Montana's list of impaired waters, the 303(d) list. Water quality standards form the basis for the targets described in Section 4. Pollutants addressed in this TMDL plan include: metals, nutrients and sediment. Section 3.3.2 provides a summary of the applicable water quality standards for each of these pollutants.

3.3.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a water body based on the potential of the water body to support those uses. Designated Uses or Beneficial Uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of "uses" of state waters including: growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana Water Quality Act (WQA) directs the Board of Environmental Review (BER, i.e., the State) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (Administrative Rules of Montana (ARM) 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed based classification system with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply. However, the quality of that water body must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or non-point source discharges may not make the natural conditions worse.

Modification of classifications or standards that would lower a water's classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions can only occur if the water was originally miss-classified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in Table 3-4. All water bodies within the Boulder River TPA are classified as B-1.

Table 3-4. Montana surface water classifications and designated beneficial uses	
Classification	**Designated uses**
B-1 CLASSIFICATION:	Waters classified B-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

3.3.2 Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

<u>Numeric</u> surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular DEQ-7 (MDEQ, February 2006). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. <u>Chronic</u> aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. <u>Acute</u> aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the <u>nondegradation</u> rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant" or an authorization to degrade must be granted by the Department. However, under no circumstance may standards be exceeded. It is important to note that, waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that the water body. Nondegradation rules do not apply to impaired streams and apply only where there are existing numeric water quality standards.

<u>Narrative</u> standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a water body. Uses may be impaired by toxic or harmful conditions (from one or a combination of

parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi and algae.

The standards applicable to the list of pollutants addressed in the Boulder River TPA are summarized below.

3.3.2.1 Nutrients

The narrative standards applicable to nutrients elsewhere in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.,). The prohibition against the creation of "conditions which produce undesirable aquatic life" is generally the most relevant to nutrients.

Most waters of Montana are protected from excessive nutrient concentrations by narrative standards. The exception is the Clark Fork River above the confluence with the Flathead River, where numeric water quality standards for total nitrogen (300 ug/l) and total phosphorus (20 ug/l upstream of the confluence with the Blackfoot River and 39 ug/l downstream of the confluence) as well as algal biomass measured as chlorophyll a (summer mean and maximum of 100 and 150 mg/m^2, respectively) have been established.

3.3.2.2 Sediment

Sediment (i.e., coarse and fine bed sediment) and suspended sediment are addressed via the narrative standard identified in Table 3-5. The standard does not allow for harmful or other undesirable conditions related to increases above naturally occurring levels or from discharges to state surface waters. This is interpreted to mean that water quality goals should strive toward a condition in which any increases in sediment above naturally occurring levels are not harmful, detrimental or injurious to beneficial uses (see definitions in Table 3-2).

Table 3-5. Applicable rules for sediment-related pollutants

Rule(s)	Standard
17.30.623(2)	No person may violate the following specific water quality standards for waters classified B-1.
17.30.623(2)(f)	No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(a)	Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines.

Table 3-5. Applicable rules for sediment-related pollutants

Rule(s)	Standard
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.
	The maximum allowable increase above naturally occurring turbidity is: 0 NTU for A-closed; 5 NTU for A-1, B-1, and C-1; 10 NTU for B-2, C-2, and C-3)
17.30.602(17)	"Naturally occurring" means conditions or material present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil, and water conservation practices have been applied.
17.30.602(21)	"Reasonable land, soil, and water conservation practices" means methods, measures, or practices that protect present and reasonably anticipated beneficial uses. These practices include but are not limited to structural and nonstructural controls and operation and maintenance procedures. Appropriate practices may be applied before, during, or after pollution-producing activities.

3.3.2.3 Metals

Numeric criteria for metals in Montana include specific standards for the protection of both aquatic life and human health. As described above, acute and chronic criteria have been established for the protection of aquatic life. The criteria for some metals vary according to the hardness of the water. The standards for cadmium, copper, chromium (III), lead, nickel, and silver vary according to the hardness of the water. These standards have an inverse relationship to toxicity (decreasing hardness causes increased toxicity). The applicable numeric criteria for the metals of concern in the Boulder River TPA are defined in *Montana DEQ Circular, DEQ-7: Montana Numeric Water Quality Standards* and are presented in Table 3-6.

Table 3-6. Montana numeric surface water quality standards for metals

Parameter	Aquatic Life (acute) (µg/L)[a]	Aquatic Life (chronic) (µg/L)[b]	Human Health (µg/L)[a]
Chromium (III) (TR)	579 @ 25 mg/L hardness[c]	28 @ 25 mg/L hardness[c]	—
Copper (TR)	3.8 @ 25 mg/L hardness[c]	2.9 @ 25 mg/L hardness[c]	1,300
Iron (TR)	—	1,000	—
Lead (TR)	14 @ 25 mg/L hardness[c]	0.5 @ 25 mg/L hardness[c]	15
Nickel (TR)	145 @ 25 mg/L hardness[c]	16 @ 25 mg/L hardness[c]	100
Silver (TR)	0.4 @ 25 mg/L hardness[c]	—	100

[a]Maximum allowable concentration.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]Standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L)
Note: TR = total recoverable.

SECTION 4.0
POLLUTANT ASSESSMENT AND IMPAIRMENT STATUS

4.1 Introduction

Section 4.0 includes an evaluation of existing data for each pollutant-impaired segment identified on the 2006 303(d) list in the Boulder Watershed TMDL Planning Area. Existing data for each segment is evaluated in comparison to water quality targets. Segments not meeting water quality targets are determined to be impaired and require the establishment of Total Maximum Daily Loads. A summary of all water body segments requiring TMDL development is given in Section 4.3. TMDLs and load allocations for these segments are given in Section 5.

Water body segments on the 2006 303(d) List and associated causes of impairment reviewed in this document are included in Table 4-1. Segment locations are given in Figure 3-1. Note that several probable causes of impairment are not addressed in this document. They include:

- Nitrate/Nitrite and Total Kjeldahl Nitrogen (segment MT43B004_132), and
- Phosphorus (Total), Nitrate/Nitrite, Total Kjeldahl Nitrogen, Excess Algal Growth (segment MT43B004_133)

As these pollutants were newly listed in 2006, resources were not available to provide adequate assessment and verification of these pollutant listings at the time of document production. DEQ will address these pollutants at a later date.

Table 4-1. 2006 303(d) listings in the Boulder Watershed TMDL Planning Area

MT Water Body Segment Identifier	Water body Segment	Probable Causes of Impairment
MT43B004_131	Boulder River (from the mouth to 5 miles upstream)	Copper Iron Lead Silver Low flow alterations
MT43B004_132	Boulder River (from 5 miles upstream of the mouth to the National Forest boundary)	Chromium Nickel Nitrate/Nitrite Total Kjeldahl Nitrogen Alteration of vegetative covers
MT43B004_133	Boulder River (from the National Forest boundary to the East Fork Boulder River confluence)	Phosphorus (Total) Nitrate/Nitrite Total Kjeldahl Nitrogen Excess Algal Growth
MT43B004_134	Boulder River (from the East Fork Boulder River to the headwaters)	Copper Lead
MT43B004_141	East Boulder River (from the mouth to the Elk Creek confluence)	Chlorophyll-a Low flow alterations Anthropogenic substrate alterations Sedimentation/Siltation
MT43B004_142	East Boulder River (From Elk	Chlorophyll-a

Table 4-1. 2006 303(d) listings in the Boulder Watershed TMDL Planning Area

MT Water Body Segment Identifier	Water body Segment	Probable Causes of Impairment
	Creek to the National Forest boundary)	Low flow alterations
MT43B004_143	East Boulder River (From the National Forest boundary to the headwaters)	None

4.2 Assessment Framework

Assessing compliance with water quality targets, and subsequent determination of whether a TMDL is necessary for each water body segment involves **three steps:**

1. **Evaluation of pollutant sources**

Pollutant sources in a watershed are both natural and anthropogenic. Both natural and anthropogenic sources must be considered when developing appropriate water quality targets. TMDLs are not developed for streams that are not meeting water standards due solely to ‘naturally occurring’ pollutants.

2. **Development of water quality targets** that represent water quality conditions that are unimpaired for the pollutant of concern

A required component of TMDL plans is the establishment of numeric water quality criteria or *targets* that represent a condition that meets Montana’s ambient water quality standards. Numeric targets are measurable water quality parameters that, either by themselves or in combination with others, reflect compliance with water quality standards (narrative and numeric) or represent a water quality condition that is unimpaired for the pollutant of concern. For pollutants with numeric standards (metals, toxins), the established state numeric standard as defined in *DEQ Circular DEQ-7* is typically adopted as the water quality target. For pollutants with narrative standards (sediment, nutrients), a translation of the narrative standard into a measurable, numeric surrogate parameter(s) is necessary. Depending on the nature of the pollutant, processes affecting impairment conditions and other factors, either a single target parameter or a suite of target parameters may be employed to evaluate whether water quality standards are met for the stream in question.

Targets utilized herein represent numeric interpretations of water quality standards at the time of document preparation. As water quality standards or assessment and evaluation tools are refined or further developed, DEQ may modify targets to better reflect the state’s process for evaluating compliance with water quality standards.

3. **Comparison of existing data with water quality targets** to evaluate water quality target compliance and, consequently, determine whether a TMDL is necessary.

Compliance with water quality targets is evaluated by comparing existing water quality data and information to the established targets. Determination of compliance typically involves evaluation of many data types distributed both spatially and temporally, some of which may meet water quality targets, and some of which may not. Where such condition exists, a discussion of data and its utility in characterizing existing conditions is presented, followed by a determination of whether the stream is impaired and therefore whether a TMDL is required. Criterion for evaluating compliance with targets is defined in the **Basis for Target Values** within each specific target description below.

4.3 East Boulder River Sediment Assessment (Segment MT43B004_141 and MT43B004_142)

The 2006 303(d) list status of water bodies in the Boulder River TPA is summarized in Section 3.2. East Boulder River segment MT43B004_141 (from the mouth to the Elk Creek confluence) is the only segment on the 2006 303(d) listed as impaired for sedimentation/siltation, and identifies aquatic life and cold-water fisheries as the beneficial uses that are impaired. Since its original listing for sediment on the 2000 303(d) list, new data and information relevant to sediment impairment determinations has been gathered. Section 4.3 provides an assessment of sediment sources, sediment water quality targets, and an evaluation of existing conditions and data with respect to water quality targets for segment MT43B004_141. While only MT43B004_141 is listed for sediment impairment, data from upstream segment MT43B004_142 is evaluated as well because these segments are similar in setting and character. Section 4.3 concludes with a determination of whether segments are impaired for sediment and consequently whether TMDLs are required.

4.3.1 Sediment Sources

There are many factors that influence sediment in a stream. Geophysical attributes such as stream depth, stream gradient, flow, precipitation, geology, soils, and channel roughness have a great influence of the size and distribution of sediment found within a stream. In the East Boulder watershed, naturally occurring sediment includes sediment derived from natural processes consistent with clear, cold, mountain stream systems that support cold-water fisheries and associated aquatic life. Human management, however; such as grazing, timber harvest, road building, and flow alterations have the potential to alter these geophysical attributes, leading to a detrimental change in the naturally occurring bedded or suspended sediments that are found in the stream substrate and water column.

Changes in the sediment regime can affect species living within streams. Siltation or deposited sediment can smother habitat, food, and eggs and reduce substrate dissolved oxygen and flow necessary for the sustenance of aquatic organisms. Suspended solids can abrade fish gills, reduce visibility/light penetration, alter feeding habitats, cause stress, and reduce primary production (Berry et al. 2003). In addition, not all aquatic life responds the same to sediment. For example, the response of the fish community to a sediment related stressor might not be the same as the response by the macroinvertebrate community. Various species of fish and aquatic life also respond differently to sediment based on tolerance and biological adaptability (Berry et al., 2003).

Clearly, understanding the physical setting and the natural and anthropogenic sources and processes operating in the East Boulder River watershed is important when evaluating compliance with water quality targets or standards. That is, targets shall identify a water quality condition that is unimpaired given known physical characteristics and ‘naturally occurring’ sources and processes.

Probable anthropogenic sources of sediment-related impairment of the beneficial uses in the East Boulder River identified on the **2006 303(d) list** include:

- **Flow alterations from water diversions**
- **Streambank modifications/destabilization**

Flow alteration is commonly considered water *quantity* rather than water quality issues; however changes to stream flow can have a profound effect on the proper functioning of stream systems and can be a major factor influencing water quality impairments. Stream channel form evolves and stabilizes over long time periods based on the amount of stream flow (energy) and sediment supply (Leopold et al., 1964; Rosgen, 1996). When the balance between sediment supply and stream energy is disrupted, changes in channel form result. Decreases in stream energy may result in an inability of the stream to effectively transport sediments, thereby causing aggradation, or deposition of sediments in the stream channel, which further contributes to a decrease in stream energy by creating a wider and shallower channel. Consequently, appropriate duration and magnitude of peak flows (i.e. bankfull or flood flows) and base flows are critical to a stream’s ability to transport sediments. Sustained low flows, whether from flow regulation, channel alteration, drought, or other natural conditions can lead to sediment-related impairments, and while TMDLs are not required for water quantity-related issues, flow alteration has been identified as a cause of sediment-related impairments on the 2006 303(d) list and is acknowledged as a factor that influences impairment condition.

Streambank modifications refer to a variety of impacts to the stream channel and associated riparian zone. These may include: removal or alteration of streamside vegetation, riparian encroachment from construction or streamside development, removal of large woody debris, alteration of channel form or substrate, bank erosion, or other alterations to terrestrial and aquatic habitat elements. Streambank modification can be a contributor or strong influence on sediment loading. For instance, removal of riparian vegetation, especially trees and woody shrubs, may lead to bank instability and increased bank erosion and consequently increases in sediment loading to a stream. Likewise, vegetation removal may also reduce the ability of vegetated buffer zones to intercept sediment-laden runoff from uplands during storm or runoff events.

In addition to flow alterations and streambank modifications, other anthropogenic sources of fine sediment that have the potential to contribute to sediment impairment in the East Boulder watershed include:

- Sediment associated with dirt roads & road crossings
- Sediment from erosion and surface runoff associated with agricultural land management (grazing practices, farming practices)
- Exacerbated erosion due to riparian encroachment (construction & streamside development)
- Excessive sediment loads from tributaries

- Sediment derived and delivered from irrigation ditches

4.3.2 Sediment Targets

Montana's water quality standards for sediment are narrative and are addressed via the narrative criteria identified in Table 3-5. These narrative criteria do not allow for harmful or other undesirable conditions related to increases above *'naturally occurring'* levels or from discharges to state surface waters. Sediment levels are to be compared to that which is 'naturally occurring', which is defined as the sediment condition found in water bodies in an undisturbed state, or alternatively, to the sediment conditions of water bodies influenced by material in runoff or percolation from developed land where *all reasonable land, soil, and water conservation practices have been applied* (see MCA 75-5-306). Reasonable land, soil, and water conservation practices are those actions that protect present and reasonably anticipated beneficial uses (see ARM 17.30.602(24)) and may not necessarily be the ones that are presently in place.

To determine if the applicable water quality standards are met for pollutants with narrative criteria, it is necessary to develop measurable, numeric interpretations of the narrative criteria – water quality targets. Consider the narrative standard for sediment (ARM 17.30.623[2][f]):

"No increases are allowed above ***naturally occurring concentrations*** of sediment or suspended sediment (except a permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or ***render the waters harmful,*** detrimental, or injurious to public health, recreation, safety, welfare, livestock, ***wild animals, birds, fish, or other wildlife"*** (emphasis added).

An appropriate sediment target suite, therefore, should reflect threshold levels of sediment that 1) illustrate sediment loading above naturally occurring conditions, and 2) are harmful to human health, fisheries, aquatic life, etc. An example of a narrative sediment standard stated as a numeric target is:

"the percentage of fine particles <2mm diameter in stream riffle substrate shall be less than 10%."

This target relates to the sediment standard as it represents a numeric expression of an in-stream condition of fine sediment below concentrations found to be harmful to aquatic life. As the sediment standard *also* does not allow increases above 'naturally occurring', characterizing a numeric expression of natural occurring conditions for a given stream or stream type is crucial in developing appropriate water quality targets for sediment.

Because <u>aquatic life</u> and <u>cold-water fisheries</u> are identified as the beneficial uses that are impaired due to sediment, targets are developed that represent sediment conditions that demonstrate support of these uses and to verify whether these beneficial uses are presently impaired due to sediment.

While it is widely acknowledge that changes in sediment can greatly affect the biota within the system, measuring the direct impact of sediment on biotic systems is difficult for at least a couple reasons: 1) it is not always possible to discriminate between an aquatic species response to sediment versus a response from some other stressor and 2) the sediment regime in most streams is both spatially and temporally variable. Because of these concerns there is not one single measurement or standard to be used to determine if an anthropogenic mediated sediment increase or decrease is impairing fish and aquatic life beneficial uses in Montana streams. Because in many cases no single measurement has been shown to be reliable, a suite of indicators are used to ***assess*** if sediment is impairing aquatic life and cold-water fishery beneficial uses.

A summary of chosen water quality targets for listed segments MT43B004_141 and MT43B004_142 are given in Table 4-2, followed by a rationale for choosing the selected target indicator and target value.

Table 4-2. TMDL Targets for East Boulder River segments MT43B004_141 and MT43B004_142

Target Indicator	Target Value	Assessment Method
Percent Surface Fines < 2 mm in Riffles (75th %ile value in representative data sets)	< 10%	Wolman Pebble Count (Wolman, 1954) 49-point grid (Platts et al. 1987, Hankin and Reeves 1988, Overton et al. 1997)
Macroinvertebrate Bioassessment Score	MMI score >63 for Mountain MMI MMI score >48 for Low Valley MMI O/E score > 0.80 < 1.25	Standard MDEQ protocols (DEQ, 2006)
Width-to-depth Ratio (75th %ile value in representative data sets)	< 36 for C3 Channels	Rosgen (1996)

4.3.2.1 Percent Surface Fines <2mm in Riffles

Basis for Target Indicator

Percent surface fines less than 2 millimeters is a measurement of the fine sediment on the surface of a stream bed. A substrate sampling method (generally Wolman pebble counts) is used to obtain particle sizes at various points in the stream. The percentage of fine sediments, defined as having a diameter of less than 2 millimeters, can then be calculated and compared to reference conditions, literature values, temporal trends, and spatial trends. Evaluation of this target provides evidence for support of macroinvertebrate and cold water fish aquatic life uses.

From Rowe et al., 2003 – Guide to Selection of Sediment Targets for Use in Idaho TMDLs: Various species are adapted to live and/or reproduce in very specific streambed conditions. Salmonids prefer mid-sized substrates with interstitial cover to either fine sediment or boulders and bedrock. Ephemeroptera, Plecoptera, and Trichoptera insect taxa also respond positively to gravel and cobble substrates (Waters 1995). Hill et al. (2000) found that percent fines <2mm negatively correlated with periphyton biomass in mid-Atlantic streams. In a study of 562 streams in four northwestern states, Relyea et al., (2000) found that changes in invertebrate communities occur as fine sediments <2mm increase above 20% coverage by area. In an analysis of data from 279 stream sites in Idaho, Mebane (2001) found that higher levels of surface sediment <6mm negatively affected EPT taxa and salmonid and sculpin fish species. Significant ($p < 0.05$) inverse relationships between number of EPT taxa and percentage of fine sediment measured across both bankfull and instream channel widths were found. More age classes of salmonids and sculpins were significantly ($p < 0.05$) associated with less instream fine sediments. Zweig et al. (2001) in their work on four Missouri streams determined that taxa richness significantly linearly decreased with increasing deposited sediment in 3 of 4 streams (over a range of 0 to 100% deposited sediments). Density, Ephemeroptera, Plecoptera, Trichoptera (EPT) richness, and EPT density were significantly negatively correlated with deposited sediment across all four streams. Taxa richness and EPT/Chironomidae richness were significantly negatively correlated in three streams.

From Relyea, 2005: Development of Fine Sediment Macroinvertebrate Indicators for the Yaak River TMDL: Kootenai National Forest
Stream invertebrates also can be affected when their food supply is either buried under sediments or diluted by increased inorganic sediment load and by increasing search time for food. Deposited sediments affect fish directly by smothering eggs, altering spawning habitat, and clogging overwintering habitat for young fish (Cordone and Kelly 1961). For example, the [macroinvertebrate] Plecopteran Megarcys spp. typically doesn't occur in streams with more than 30 percent fine sediment.

From USEPA, 2003: Developing Water Quality Criteria for Suspended and Bedded Sediments (SABS)
Accumulations of fine substrate particles fill the interstices of coarser bed materials, reducing habitat space and its availability for benthic fish and macroinvertebrates (Platts et al. 1983; Hawkins et al., 1983; Rinne 1988). In addition, these fine particles impede circulation of oxygenated water into hyporheic habitats.

From Suttle et al., 2004: How Fine Sediment in Riverbeds Impairs Growth and Survival of Juvenile Salmonids
Suttle et al. investigated the effects of fine sediment (<2mm diameter) on growth and survival of juvenile salmonids (*Oncorhynchus mykiss*) in a northern California stream. Results showed that increasing concentrations of fines deceased growth and survival. Furthermore, the linear relationship between increasing fine sediment and salmonid growth suggested that there is no threshold below which increased fine sediment delivery would not be detrimental to the growth of salmonids.

Basis for Target Values
It has been shown in a variety of investigations that accumulations of fine substrate particles that fill the interstices of coarser bed materials can reduce habitat space and its availability for benthic fish and macroinvertebrates. Maintaining concentrations of fine substrate sediment below levels expected to cause deleterious effects to aquatic life is protective of fisheries and associated aquatic life and is in accordance with Montana's narrative water quality standards for sediment. In the absence of true internal reference condition on which to base 'natural conditions' of fine sediment for the lower East Boulder River, best available condition was used to estimate fines for 'least-impacted' riffle conditions on the East Boulder River.

The target for percent surface fines < 2mm in riffles is <10%. A 10% fine sediment <2mm target both protects aquatic life uses and provides a margin of safety for protection of aquatic species. **Where data sets provide adequate spatial coverage of the stream segment as a whole, the 75th percentile value of the data set is used to evaluate compliance with the target value**. In situations where smaller and less spatially representative data sets are used, if the target value is exceeded in a representative riffle, the stream is considered to show potential impairment conditions unless there is appropriate evidence to otherwise suggest that the high level of fines is natural or is not causing impairment to aquatic macroinvertebrate communities.

4.3.2.2 Macroinvertebrate Bioassessment Score

Basis for Target Indicator
Siltation exerts a direct influence on benthic macroinvertebrates assemblages through several mechanisms. These include limiting preferred habitat for some taxa by filling in interstices or spaces between gravel. In other cases, fine sediment limits attachment sites for taxa that affix to substrate particles. Macroinvertebrate assemblages respond to siltation with a shift in natural or expected taxa to a prevalence of sediment tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessments scores are an assessment of the macroinvertebrate assemblage at a site and are used by the DEQ to evaluate impairment condition and beneficial use support. The advantage of these bioindicators is that they provide a measure of support of associated aquatic life, an established beneficial use of Montana's waters. Bioassessment scores represent the effects of cumulative stressors on the macroinvertebrate community, however, and do not necessarily distinguish between specific types of stressors: sediment, nutrient, temperature, habitat, low flow, etc.

In 2006, Montana DEQ adopted impairment thresholds for bioassessment scores based on two separate methodologies. The **Multi-Metric Index (MMI)** method assesses biological integrity of a sample based on a battery of individual biometrics. The **River Invertebrate Prediction and Classification System (RIVPACS)** method utilizes a probabilistic model based on the taxa assemblage that would be expected at a similar reference site. Based on these tools, the DEQ adopted bioassessment thresholds that were reflective of conditions that supported a diverse and biologically unimpaired macroinvertebrate assemblage, and therefore a direct indication of beneficial use support for aquatic life.

The MMI is organized based on the different ecoregions within Montana. Three MMIs are used to represent the various Montana ecoregions: Mountain, Low Valley, and Plains. Each region has specific bioassessment threshold criteria that represent full support of macroinvertebrate aquatic life uses. The Boulder and East Boulder watersheds fall within both Mountain and Low Valley MMI regions. The MMI score is based upon the average of a variety of individual metric scores. The metric scores measure predictable attributes of benthic macroinvertebrate communities to make inferences regarding aquatic life condition when pollution or pollutants affect stream systems and instream biota.

The RIVPACS model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled. The RIVPACS model provides a single dimensionless ratio to infer the health of the macroinvertebrate community. This ratio is referred to as the Observed/Expected (O/E) value. Used in combination, the results suggest strong evidence that a water body is either supporting or non-supporting its aquatic life uses for aquatic invertebrates.

Basis for Target Values
For the Multi-Metric Index, individual metric scores are averaged to obtain the final MMI score. The score will range between 0 and 100. **The impairment thresholds are 63 and 48 for the mountain and low valley indices, respectively.** The impairment threshold (10^{th} percentile of the reference dataset) represents the point where DEQ technical staff believed macroinvertebrates are affected by some kind of impairment (e.g. loss of sensitive taxa).

The RIVPACS impairment threshold for all Montana streams is any O/E value <0.8. However, the RIVPACS model has a bidirectional response to nutrient impairment. Some stressors cause macroinvertebrate populations to decrease right away (e.g. metals contamination) which causes the score to decrease below the impairment threshold of 0.8. Nutrient enrichment may actually increase the macroinvertebrate population diversity before eventually decreasing below 0.8. An upper limit was set to flag these situations. The 90^{th} percentile of the reference dataset was selected (1.2) to account for these situations. However, RIVPACS scores >1.0 are considered unimpaired for all other stressor types.

Most scores significantly below the RIVPACS and MMI impairment thresholds are impaired. Some model scores may be close to the threshold. These sites may be considered unimpaired in some situations. For example, a site classified in the Mountain ecoregion may have a mountain MMI score of 83, well above the mountain MMI threshold (63), and a RIVPACS score of 0.76, close to the RIVPACS impairment threshold (0.8). The assessor may determine that the macroinvertebrate community at the site is unimpaired. Ultimately, the assessor will determine the degree of impairment (i.e. moderate or severe) using best professional judgment and guidance found in the State’s bioassessment process (DEQ, 2006).

4.3.2.3 Width-to-depth Ratio

Basis for Target Indicator
Width-to-depth ratio has multiple links to sediment impairment. A wide and shallow channel reduces the power available to transport sediment, thereby increasing the potential for aggradation and pool filling. In addition, width-to-depth ratios can influence habitat quality as deeper, narrower channels provide superior fish habitat compared to wide, shallow streams. Moreover, a wide, laterally active channel can be correlated with unstable, eroding banks that contribute sediment. These links between width-to-depth ratio, sediment delivery, and stream competency make it a good indicator of *potential* sediment-related impairments. On their own, width-to-depth ratios do not provide a consistent measure of sediment or habitat impairment. In conjunction with other indicators, however, width-to-depth ratios can provide causal links to observed in-stream fine sediment deposition and habitat limitations.

Basis for Target Values
Reference values for width-to-depth ratios on a variety of stream types were collected on the Beaverhead National Forest (BNF) by Bengeyfield (USFS unpublished data) and on the Lolo

National Forest (LNF) by Riggers et al. (1998). Reference data from Bengeyfield was collected across a variety of lithologies, while reference data from Riggers et al. was collected from metasedimentary, glacial, and granitic lithologies. A summary of width-to-depth ratios for reference streams from these two investigations is given in Table 4-3.

Table 4-3. Reference width-to-depth ratios

	Beaverhead National Forest		Lolo National Forest	
Channel type	C3	C4	C3	C4
68th percentile			33	33
75th percentile	31	20	41*	41*
95th percentile			63	63

*estimated through linear interpolation

Given different sample sizes, ecoregions, stream orders, collection methodologies and site selection criteria inherent in reference investigations, target selection must be approached with an understanding of variability and uncertainty. Because reference data was not available for the Boulder River watershed, reference data from C channels in the Beaverhead and Lolo National Forests was used as surrogate reference for similar channel types in the Boulder River TPA. Typically, the DEQ utilizes the 75th percentile of reference data sets as target values for width-to-depth ratios for specific Rosgen stream types. Quartile range data was not available for the Lolo National Forest; therefore linear interpolation was used to estimate the 75th percentile of reference. Width-to-depth ratio targets will therefore be set based on the average 75th percentile of reference of the Lolo National Forest and Beaverhead National Forest reference data sets.

East Boulder River segments MT43B004_141 and MT43B004_142 are predominantly C3 type channels, therefore **a maximum width-to-depth ratio of 36:1 is proposed as a target for C3-type channels in the Boulder River TPA.** As with percent fines data, **where data sets provide adequate spatial coverage of the stream segment as a whole, the 75th percentile value of the data set is used to evaluate compliance with the target value**. In situations where smaller and less spatially representative data sets are used, if the target width-to-depth value is exceeded, the stream is considered to show potential impairment conditions unless there is appropriate evidence to otherwise suggest that the width-to-depth value is natural or is not causing fine sediment deposition.

4.3.3 Water Quality Targets Evaluation

Sediment target indicator data (substrate fines, macroinvertebrates, and width-to-depth ratios) is available at several locations (EBR-006 through EBR-009) in the lower East Boulder River (Figure 4-1). In this section, data collected at these sites is compared to the East Boulder River sediment targets established in Section 4.3.2, followed by a determination of whether the East Boulder River is impaired for sediment. While only sites EBR-008 and EBR-009 fall within the water body segment, MT43B004_141, listed for sediment impairment, data from upstream sites EBR-006 and EBR-007 (segment MT43B004_142) is evaluated in order to provide a more comprehensive evaluation of water quality conditions in the East Boulder River.

4.3.3.1 Percent Surface Fines <2mm in Riffles

Data Results
Surface fines data on the East Boulder River was collected at sampling sites EBR-006 through EBR-009 in August of 2005 using two different methods, Wolman pebble counts (Wolman, 1954) and 49-point grid (Platts et al. 1987, Hankin and Reeves 1988, Overton et al. 1997). Wolman pebble counts were conducted at three separate equidistant channel transects at each sampling site for a total of 12 individual pebble counts. Percent fines <2mm results from Wolman pebble counts are given in Table 4-4.

Table 4-4. Percent surface fines <2mm from Wolman pebble counts

	Transect					
	1	2	3			
Segment MT43B004_142				Mean	Median	75%ile
EBR006	0	0	4	1.3	0.0	
EBR007	1	0	0	0.3	0.0	
				0.8	**0.0**	**0.8**
Segment MT43B004_141				Mean	Median	75%ile
EBR008	1	2	1	1.3	1.0	
EBR009	8	10	6	8.0	8.0	
				4.7	**4.0**	**7.5**

Three 49-point grid fines assessments were conducted at equidistant measurements on each of five channel transects per sampling site for a total of 15 grid fines measurements per sampling site, and a total of 60 grid fines measurements for all sites. Percent fines <2mm results from 49-point grid fines are given in Table 4-5.

Table 4-5. Percent surface fines <2mm from 49-point grid fines

	Transect							
	1	2	3	4	5			
Segment MT43B004_142						Mean	Median	75%ile
EBR006	0	0	0	0	0			
	0	0	0	0	0			
	0	0	0	0	0	0.0	0.0	0.0
EBR007	2	0	2	3	2			
	0	2	0	0	0			
	0	0	6	0	2	1.3	0.0	2.0
						0.6	**0.0**	**0.0**
Segment MT43B004_141						Mean	Median	75%ile
EBR008	2	2	1	2	1			
	1	0	0	0	0			
	0	3	7	2	2	1.5	1.0	2.0
EBR009	20	0	2	2	2			
	12	2	1	0	12			
	17	4	2	4	2	5.5	2.0	8.0
						3.5	**2**	**2.75**

Data Discussion

Multiple channel transects at each sampling site were located at predetermined intervals, and not specifically riffle habitats, making comparison of fines data to target criteria for riffles problematic. Field photographs (Figures 4-2 through 4-6) and notes confirm limited pool habitat, and large substrate size and low flows make typical riffle habitat difficult to discern. Most field photos however, display what could be considered 'riffle habitat' for a large cobble to boulder dominated substrate. Even in the absence of easily discernable riffles, it can be reasonably assumed from the percent fines values that the East Boulder River does not suffer from excessive fine sediment deposition. The notable exception is at site EBR-009, transect 1, where the percent fines exceeded the target value. Field photos and observations show that this area was close to the confluence of the larger Boulder River and may have elevated fines due to deposition of fines originating from the Boulder River that were deposited during high-flow back-water eddies. Means, medians, and 75^{th} percentiles at all sampling sites and as well as cumulative percentiles for each segment were below target values for percent fines <2mm. **Taken in sum, data from Wolman pebble counts and 49-point grids show that East Boulder River segments MT43B004_141 and MT43B004_142 meet target criteria for percent fines <2mm in riffles.**

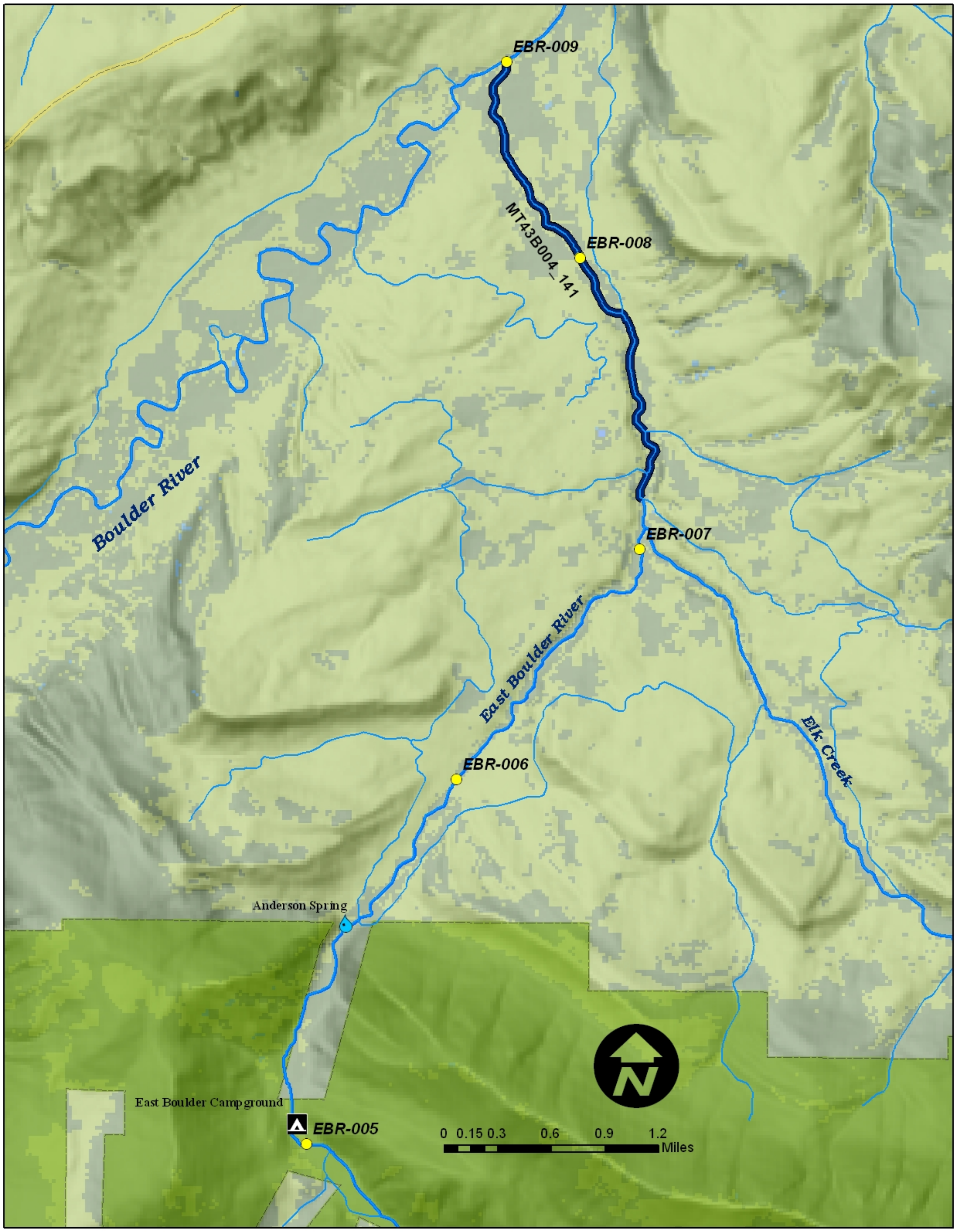

Figure 4-1. Sampling locations on the lower East Boulder River

Figure 4-2. EBR-006 channel transect

Figure 4-3. EBR-007 channel transect

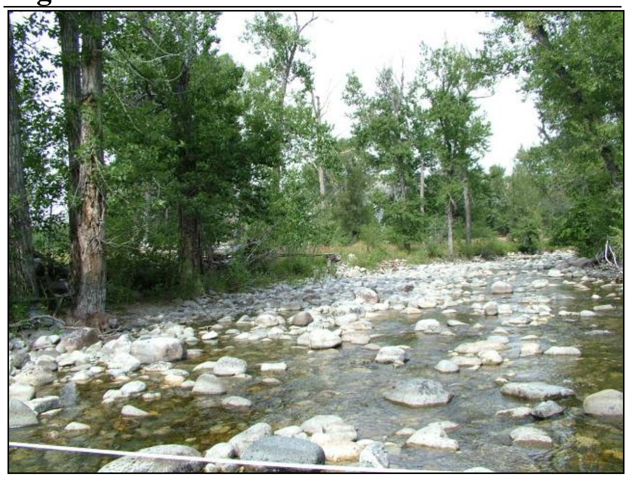

Figure 4-4. EBR-008 channel transect

Figure 4-5. EBR-009 channel transect looking upstream

Figure 4-6. EBR-009 channel transect looking downstream

4.3.3.3 Macroinvertebrate Bioassessment Score

Data Results
Macroinvertebrate data was collected at sampling sites EBR-006 through EBR-009 from year 2000 through 2004. Typically, sampling for macroinvertebrates was conducted during the late summer months (August and September), and three replicate samples were collected during each sampling event. DEQ obtained raw taxa counts of this data and applied bioassessment tools MMI and RIVPACS to evaluate whether the macroinvertebrate community demonstrated signs of impairment. In all, 54 individual samples, collected over a 5-year period, were evaluated with the bioassessment tools. Results showing the average bioassessment score at each sampling site are given in Figure 4-7 and Figure 4-8.

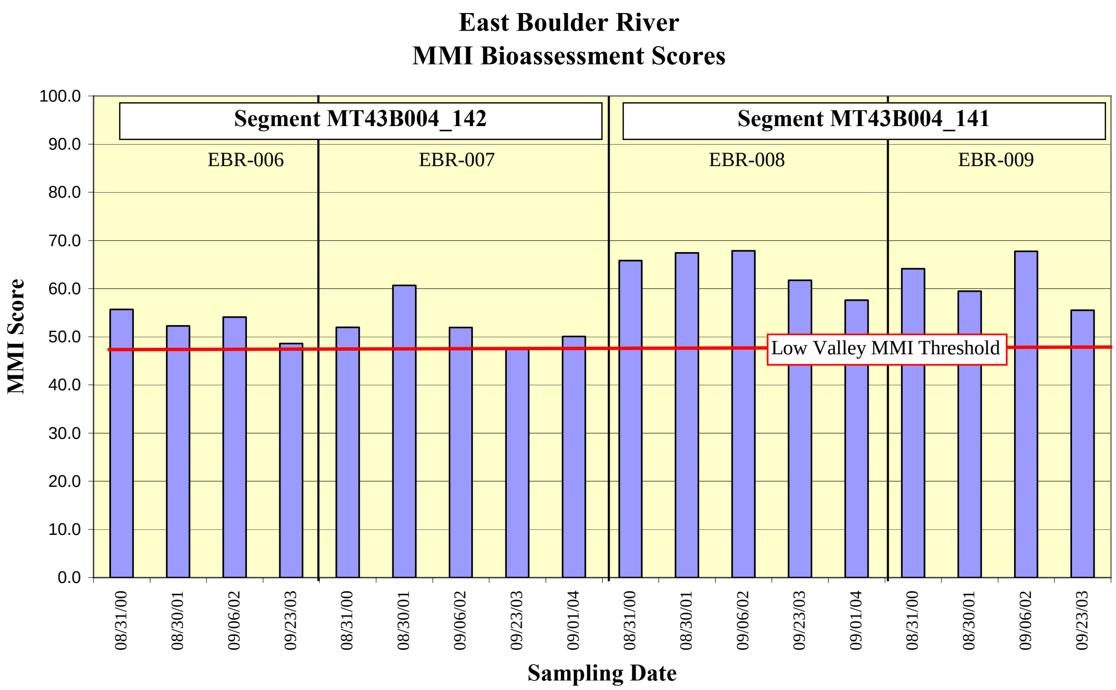

Figure 4-7. MMI bioassessment results for the East Boulder River

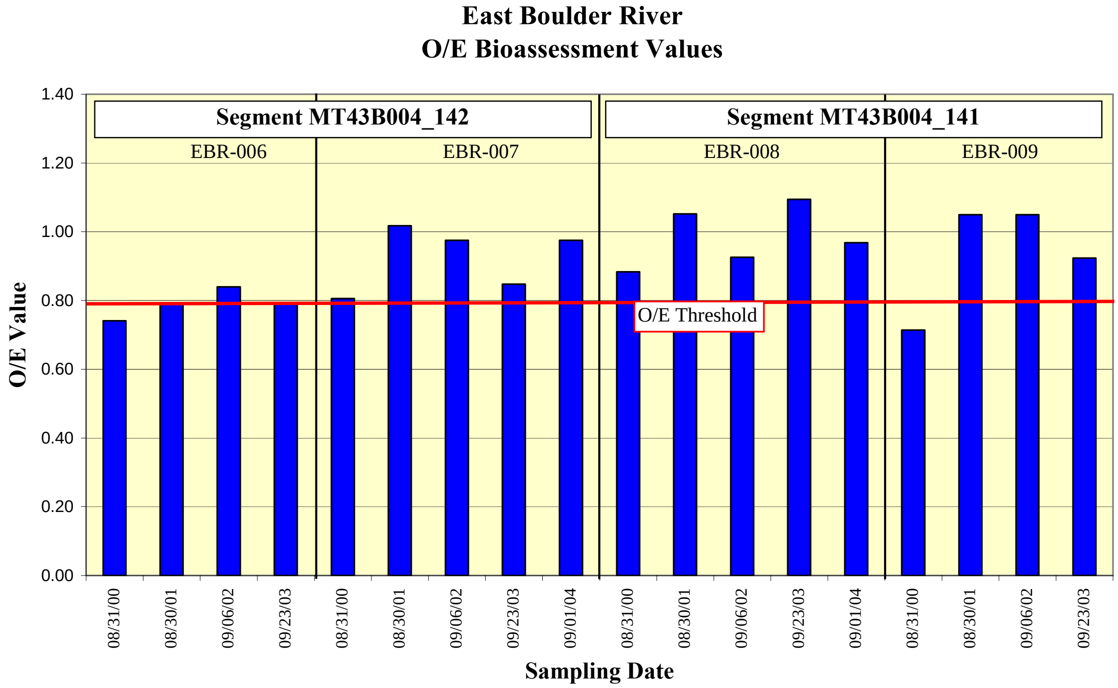

Figure 4-8. O/E bioassessment results for the East Boulder River

Data Discussion

Figure 4-7 displays mean MMI scores from three replicate macroinvertebrate samples collected at each sampling site. All sampling sites EBR-006, EBR-007, EBR-008 and EBR-009 fall within the Low Valley MMI region. With the exception of a 47.4 mean MMI score from samples collected at site EBR-007 on 9/23/03, all mean MMI scores were above impairment threshold of 48 for Low Valley MMI sites. MMI scores for segment MT43B004_141, listed as impaired on the 2006 303(d) list, demonstrated no impairment of the macroinvertebrate community.

Figure 4-8 displays mean O/E values from three replicate macroinvertebrate samples collected at each sampling site. For segment MT43B004_142, sampling site EBR-006 showed the lowest values overall, with three mean values (0.74, 0.79, and 0.79) below the impairment threshold of 0.80. MMI scores at these same sampling locations indicated full support of macroinvertebrate aquatic life use. For segment MT43B004_141, listed as impaired on the 2006 303(d) list, a single O/E value of 0.71 on 08/31/2000 was below impairment the threshold. More recent O/E values for segment MT43B004_141 demonstrated no impairment of the macroinvertebrate community.

Bioassessment scores represent the effects of cumulative stressors on the macroinvertebrate community and do not necessarily distinguish between specific types of stressors: sediment, nutrient, temperature, habitat, low flow, etc. Consequently, scores below impairment thresholds do not specifically indicate sedimentation/siltation impairment, but may indicate that other reach scale variables such as low flows, high water temperatures, or other natural or anthropogenic habitat-related impacts may be influencing the macroinvertebrate community. Additionally, low percent fines data suggests that sedimentation/siltation does not appear to be a factor effecting macroinvertebrate communities

MMI and O/E scores for East Boulder River segment MT43B004_141 are predominantly above thresholds thought to indicate aquatic life impairment and meet MMI and O/E bioassessment targets.

MMI and O/E scores for East Boulder River segment MT43B004_142 are close to impairment thresholds, however supporting percent fines data suggests that scores are likely not influenced by excessive sedimentation and siltation. Warm water temperatures due to low flows, habitat disturbance, or other reach-scale impacts, natural or unnatural, may be responsible for lower scores, particularly at site EBR-006.

4.3.3.4 Width-to-depth Ratio

Data Results
Five bankfull channel transects were conducted at each sampling site, EBR-006 through EBR-009 in August of 2005 for a total of 20 individual transects. Bankfull width-to-depth ratios (Rosgen, 1996) were calculated at each transect and are given in Table 4-6.

Table 4-6. Width-to-depth ratios in the East Boulder River

	Transect							
	1	2	3	4	5			
Segment MT43B004_142						Mean	Median	75th %ile
EBR-006	31	32	24	19	32	27.6	31	32
EBR-007	45	39	40	34	36	38.8	39	40
						33.2	**33**	**38.2**
Segment MT43B004_141						Mean	Median	75th %ile
EBR-008	37	22	35	24	24	28.4	24	35
EBR-009	48	38	31	32	23	34.4	32	38
						31.4	**31.5**	**36.5**

Data Discussion
Transect data, aerial photography, and field photographs show sampling sites EBR-006 through EBR-009 to be cobble and boulder dominated C3-type channels. The width-to-depth target for C3 channels in the Boulder TPA is <36:1. While some individual width-to-depth ratios exceed target criteria, mean and median width-to-depth ratios for segments MT43B004_141 and MT43B004_142 meet target criteria. The 75th percentile of width-to-depth ratio data for segments MT43B004_141 and MT43B004_142 slightly exceed the target criteria. However, in the absence of observed fine sediment accumulation and the relative closeness of percentile values to width-to-depth targets, **it is concluded that 75th percentile exceedances of the width-to-depth target do not contribute to fine sediment accumulation or aquatic habitat limitations.**

4.3.3.5 East Boulder River Water Quality Targets Summary

Table 4-7. TMDL sediment target evaluation summary for East Boulder River

Target Indicator	Target Value	Target Evaluation
Segment MT43B004_142		
Percent Surface Fines < 2mm in Riffles	< 10%	Meeting target
Macroinvertebrate Bioassessment Score	MMI score >48 for Low Valley MMI O/E score > 0.80 < 1.25	8 of 9 MMI values meet target 6 of 9 O/E values meet target
Width-to-depth Ratio	< 36 for C3 Channels	75th %ile slightly exceeding target
Segment MT43B004_141		
Percent Surface Fines < 2mm in Riffles	< 10%	Meeting target
Macroinvertebrate Bioassessment Score	MMI score >48 for Low Valley MMI O/E score > 0.80 < 1.25	9 of 9 MMI values meet target 8 of 9 O/E values meet target
Width-to-depth Ratio	< 36 for C3 Channels	75th %ile slightly exceeding target

Data review and evaluation shows that water quality targets for sediment for the East Boulder River are predominantly being met. Width-to-depth ratio targets are not being met at all sampling sites on the East Boulder River and the 75th percentile of measures width-to-depth ratios slightly exceed target criteria, however, supporting data shows that in-stream fine sediment conditions are well below target levels, and aquatic habitats are supporting healthy macroinvertebrate populations, suggesting that the width-to-depth ratios do not appear to be a limiting factor in the support of macroinvertebrate aquatic life uses in the East Boulder River. **Existing data evaluation supports the decision that East Boulder River segments MT43B004_141 and MT43B004_142 are not impaired for sediment, and TMDLs are not required.**

In addition, percent fines data suggests that East Boulder River segment MT43B004_141 is not impaired for **anthropogenic substrate alterations** as stated in the 2006 303(d) list. **Low flow alterations** (segments MT43B004_141 and MT43B004_142) were not assessed as part of this document, and while low flow alterations do not appear to be affecting sedimentation/siltation in the East Boulder River, it is not known the extent to which low flow alterations are affecting aquatic life communities or other beneficial uses.

4.3.4 Further Recommendations

4.3.4.1 Low Flow Management

Segments MT43B004_141 and MT43B004_142 of the East Boulder River are listed as impaired due to low flow alterations and are listed on the Montana Department of Fish, Wildlife & Parks' list of chronically dewatered streams. While low flow alterations do not appear to be contributing to sediment-related impairments, low flows in the East Boulder River can impact agricultural, recreational, and aquatic life beneficial uses. Low flows can also influence nutrient concentrations and algal conditions.

DEQ recommends that local landowners, watershed organizations, and resource managers continue to work collaboratively with local and state agencies to ensure protection of beneficial uses through flow monitoring and the development of flow enhancement and management plans. Key participants should include: local landowners, Sweet Grass Conservation District, Boulder River Watershed Group, Montana Department of Fish, Wildlife & Parks, Montana Department of Natural Resources & Conservation, and the Montana Department of Environmental Quality. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include: Montana Water Trust, Natural Resources Conservation Service, Northern Plains Resource Council, Cottonwood Resource Council, and the Montana Water Center.

4.3.4.2 Sediment and Habitat Monitoring and Assessment

Quantitative sediment and habitat data (width-to-depth ratios, percent surface fines <2mm) used to evaluate compliance with water quality targets was collected in the summer of 2005. In order to evaluate spatial and temporal water quality trends over a variety of conditions, the DEQ recommends an evaluation of methods and sampling locations used in this effort, and development of a long-term Sediment and Habitat Monitoring Plan that incorporates, but is not limited to the following monitoring parameters.

Percent fines <2mm in riffle habitats
Section 4.3.2.1 provides rationale behind utilization of riffle fines as an indicator of aquatic life support. Long-term monitoring should identify representative riffles within segments MT43B004_141 and MT43B004_142 and establish a sampling frequency.

Percent fines <6mm in pool tail habitats
Percent fines <6mm in pool tail habitats is an indicator of the potential spawning success of salmonids. Trout typically establish redds in pool tail habitat. Excessive fine sediment in pool tails can inhibit spawning success of salmonids. Long-term monitoring should identify areas of potential salmonid spawning and establish a sampling frequency that allows evaluation of beneficial use support for cold-water fishery.

Fish habitat indicators
In addition to percent fines data, habitat assessments should be conducted that provide information on suitability of the East Boulder River to support and propagate cold-water fish species. Habitat assessments may provide information that can assist in identifying limitations and prioritizing fisheries enhancement efforts in the East Boulder watershed.

Bioassessments
Macroinvertebrate and periphyton sampling and assessment can provide information regarding biological response to pollutant loads and impacts from other pollution-related sources. Bioassessments provide a direct indicator of beneficial use support for aquatic life and, in

conjunction with existing bioassessment data, can inform as to long-term biological trends in the East Boulder River.

The framework and objectives of a long-term Sediment and Habitat Monitoring Plan should be developed in a way as to adequately and accurately characterize sediment and habitat conditions in the East Boulder watershed and should allow for data collection that meets a variety of objectives, including the continued evaluation of beneficial use maintenance. The recommendations provided herein do not assign responsibility to specific agencies or organizations for monitoring and assessment activity, but act to promote collaborative and coordinated resource management so that all beneficial uses may be maintained and protected.

4.4 East Boulder River Nutrient and Algal Assessment (Segments MT43B004_141 and MT43B004_142)

In 1996 the entire East Boulder River, from headwaters to mouth, was listed as ‘threatened’ due to nutrients with the probable source being resource extraction. The basis for this original listing was founded on an interpretation of the term, ‘threatened’. In 1997, the term ‘threatened’ was defined in the Montana Water Quality Act [MCA 75-5-103 (31)]. Consequently, the East Boulder River did not fit the definition of a ‘threatened water body’ as proposed sources are subject to pollution control measures through a state of Montana MPDES permit, and subsequent DEQ review determined that insufficient data existed to support any adverse water quality trends. DEQ later split the East Boulder River into three discrete segments (figure 3-1), based on ecoregional influences and changes in stream type and character.

- MT43B004_141 (from the mouth to the Elk Creek confluence)
- MT43B004_142 (from Elk Creek to the National Forest boundary)
- MT43B004_143 (from the National Forest Boundary to the headwaters)

Each segment was evaluated for impairment separately, and the 2000 303(d) list reflected the updated impairment status for each segment. East Boulder River segments, MT43B004_141 and MT43B004_142 were listed as impaired for chlorophyll-a (algal growth), and identified aquatic life, cold-water fisheries, and recreation as the impaired beneficial uses. Segment MT43B004_143 was found be fully supporting its beneficial uses and is not considered impaired. The 2006 303(d) list status of water bodies in the Boulder River TPA is summarized in Section 4.0.

Section 4.4 provides an assessment of nutrient sources affecting chlorophyll-a growth, nutrient and chlorophyll-a water quality targets, and an evaluation of existing conditions and data with respect to water quality targets for impaired segments MT43B004_141 and MT43B004_142. Section 4.4 concludes with a determination of whether the segment is impaired for chlorophyll-a and consequently whether a TMDL is required. As segment MT43B004_143 is listed as fully supporting its beneficial uses, a review of existing data is not provided in this document. Water quality conditions for this segment, along with data review and analysis can be found in Land & Water Consulting (2003), Advent (2005) and in unpublished water quality monitoring reports generated by Kuipers and Associates, LLC and discharge monitoring report (DMR) data submitted to the DEQ from the Stillwater Mining Company as a permit requirement.

4.4.1 Nutrient Sources

Probable anthropogenic sources of nutrient/chlorophyll-a impairment of the beneficial uses in the East Boulder River identified on the **2006 303(d) list** include:

- **Agriculture sources**
- **Other unknown sources**

Agricultural sources include nutrients such as phosphorus and nitrogen in the form of fertilizers that are applied to crops to enhance production. Agricultural associated nutrients are also found in manure, sludge, irrigation water, legumes, and crop residues. When nutrients are applied in excess of plant needs, they can wash into aquatic ecosystems where they can cause excessive plant growth which can impair recreation and aquatic life in the water bodies. In addition to cropland areas, overgrazing and poorly managed agricultural lands can expose soils, increase erosion, encourage invasion by undesirable plants, impact fish habitat, and reduce riparian vegetation necessary to maintain streambanks and provide habitat.

Stream de-watering through irrigation can result in higher water temperatures, decreased solar radiation attenuation, and increased sensitivity to external nutrient loads. These factors can contribute to and exacerbate nuisance algal growth (excessive chlorophyll-a).

In addition to agricultural non-point sources, there exists a **nutrient point-source** that has the potential to impact surface waters: the East Boulder Mine permitted wastewater discharge. The East Boulder Mine holds a Montana Pollutant Discharge Elimination System (MPDES) permit that regulates discharge of nutrients, predominantly from ammonium nitrate blast residue, through ground water. To date, there has been no direct surface water discharge from the mine. The mine's ground water discharges are regulated through the mine's MPDES discharge permit.

Other potential nutrient sources include roads and crossings, septic systems (particularly near-stream and/or failing systems), nutrient inputs from tributaries that flow into the East Boulder River, as well as nutrient inputs from natural springs and seeps. Anderson Spring (figure 4-11), a natural spring on the East Boulder River, has documented water temperatures and nitrate concentrations above that of the East Boulder River. This combination may affect algal growth, especially during late summer low flows.

4.4.2 Targets

Montana's water quality standards for nutrients are narrative and are addressed via the narrative criteria identified in Section 3.0. These narrative criteria do not allow for "*substances attributable municipal, industrial, agricultural practices or other discharges that will...(e) create conditions which will produce undesirable aquatic life*" (ARM 17.30.637).

Excessive chlorophyll-a concentrations are categorized by the DEQ as 'undesirable aquatic life'. Nitrogen and phosphorus are required nutrients for chlorophyll-a growth and are usually the limiting factors to growth, particularly in sparsely shaded streams. Excessive nitrogen and phosphorus concentrations can therefore be used as indicators of nuisance algae in these types of systems. Over the past 6 years DEQ has made good progress in developing numeric nutrient criteria for wadeable streams and small rivers of the state. Work completed so far has established that:

- Level III and Level IV ecoregions (Woods et al. 2002) provide a statistically-meaningful classification scheme that can be used to establish expectations for regionalized nutrient concentrations (Varghese and Cleland 2005)
- Nutrient concentrations reported in five different stressor-response studies (nutrient as stressor, impact to water use as response) correspond to nutrient concentrations at about the 85^{th} percentile of the reference frequency distributions from the ecoregion matching each study, and
- Bootstrapping techniques can be used to develop confidence intervals around the 85^{th} (or any) percentile of a nutrient concentration frequency distribution, for the purpose of framing the confidence (as concentration ranges) around that percentile (Varghese and Cleland 2006).

Since the 85^{th} percentile of reference has generally been shown to represent, empirically, the nutrient concentration where use impacts begin (Suplee et al., *in press*) the 85^{th} percentile of reference nutrient distributions can be used to assist in interpretation of the narrative nutrient standard and as a basis for TMDL nutrient target development. *Used in conjunction* with benthic chlorophyll-a data, nutrient concentrations at the 85^{th} percentile of reference can be used to help assess impacts to beneficial use. The benthic chlorophyll-a criteria is 50 mg/m^2, which is the transition concentration used by MDEQ in determining not/*least impaired* to *moderately impaired* streams (MDEQ 2005, Appendix A).

The East Boulder River originates in the Level III ecoregion “Middle Rockies” (Woods et al. 1999) and flows through the Northwestern Great Plains ecoregion before entering the Boulder River south of McLeod, MT (figure 4-9). The East Boulder River exhibits characteristics of a mountain stream. Its waters are clear and cold with a boulder and cobble dominated substrate that supports a diverse assemblage of macroinvertebrates suited to mountain and foothill environs. Additionally, the East Boulder River support salmonids and other fish species associated with cold water streams. So, though East Boulder River segments MT43B004_141 and MT43B004_142 flow predominantly through the Northwestern Great Plains ecoregion, they originate upstream in the Middle Rockies ecoregion, making the nutrient reference values associated with the Middle Rockies ecoregion more akin to the types of nutrient concentrations expected in the East Boulder River. As such, reference nutrient criteria from Middle Rockies ecoregions will be employed in establishing appropriate nutrient water quality targets for the East Boulder River. The 85^{th} percentile of reference nutrient concentrations during the summer growing season (when algal concentrations are highest) for the Middle Rockies ecoregion is presented in table 4-8.

Table 4-8. 85th percentile for reference nutrient concentrations in the Middle Rockies ecoregion (growing season)

Parameter	Sample N	85th percentile
$NO_3 + NO_2$	116	0.04 mg/L
Total Phosphorus (TP)	110	0.02 mg/L
Total Nitrogen (TN)	22	0.32 mg/L
Total Kjeldahl Nitrogen (TKN)	87	0.30 mg/L

The Level III Middle Rockies ecoregion in the East Boulder watershed consist of two Level IV ecoregions: Gneissic-Schistose Forested Mountains and Absaroka-Gallatin-Madison-Bridger Sedimentary Mountains. Reference data for nutrient forms NO_3+NO_2 and total phosphorus exists for these two Level IV ecoregions. Percentile statistics for reference summer concentrations is given in table 4-9 and table 4-10.

Table 4-9. 85th percentile for reference $NO_3 + NO_2$ concentrations in the Middle Rockies level IV ecoregions (growing season)

Level IV ecoregion	Sample N	85th percentile
Gneissic-Schistose Forested Mountains	17	0.12 mg/L
Absaroka-Gallatin-Madison-Bridger Sedimentary Mountains	5	0.03 mg/L

Table 4-10. 85th percentile for reference total phosphorus concentrations in the Middle Rockies level IV ecoregions (growing season)

Level IV ecoregion	Sample N	85th percentile
Gneissic-Schistose Forested Mountains	10	0.28 mg/L
Absaroka-Gallatin-Madison-Bridger Sedimentary Mountains	5	0.04 mg/L

Nutrient data collected in the upper East Boulder River upstream from anthropogenic influences show natural background $NO_3 + NO_2$ concentrations up to 0.11 mg/L during summer months, indicating that the Middle Rockies ecoregional values may not adequately characterize reference conditions in the upper East Boulder River for some nitrogen forms. Reference percentiles from Level IV ecoregion appear to more accurately characterize conditions in the East Boulder watershed.

Reference 85th percentile $NO_3 + NO_2$ concentrations for Level IV ecoregions (table 4-9) ranged from 0.03 to 0.12 mg/L, however sample size was much lower (n=17) than that for Level III reference values (n=116). The average 85th percentile value between the Level III (Middle Rockies) ecoregion and Level IV (Gneissic-Schistose Forested Mountains) ecoregion was therefore chosen as the $NO_3 + NO_2$ target value for the East Boulder River. **The result is a $NO_3 + NO_2$ target value of 0.08 mg/L.**

Total nitrogen and TKN reference values were not available for Level IV ecoregions. Because Middle Rockies 85th percentile sample size (n=22) for TN is significantly lower than that for both TKN (n=87) and $NO_3 + NO_2$ (n=116), a more justifiable TN target, is calculated by adding the $NO_3 + NO_2$ target of 0.08 mg/L to the TKN 85th percentile concentration of 0.30 mg/L. **The result is a TN target of 0.38 mg/L.**

Total phosphorus concentrations in the same area were predominantly below ecoregional reference, suggesting that total phosphorus reference concentrations in the East Boulder River were within expected conditions for Middle Rockies reference streams. No local adjustments were made to the total phosphorus target from Level III reference values. **The result is a TP target of 0.02 mg/L.**

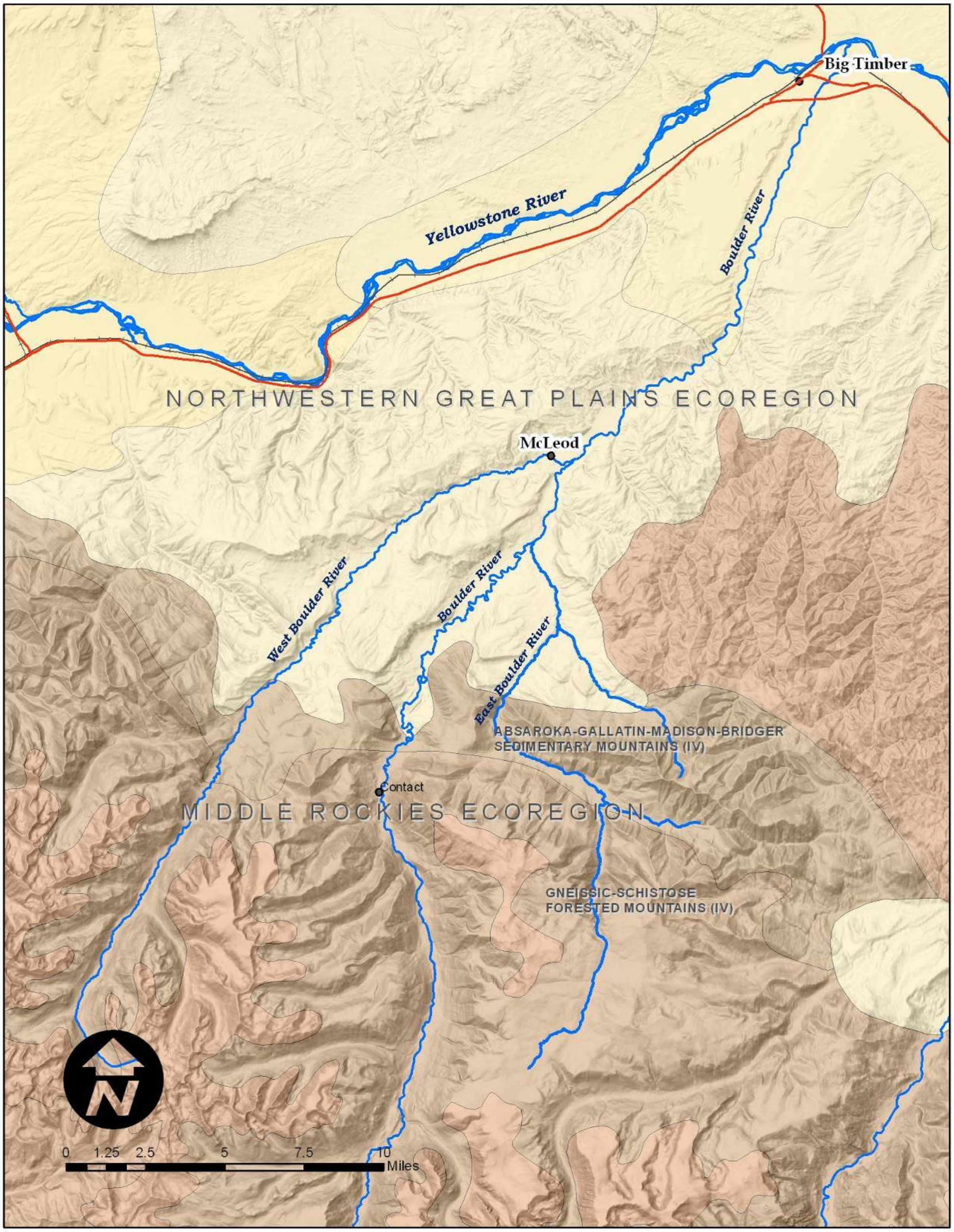

Figure 4-9. Level III and IV ecoregions: Boulder River TMDL Planning Area

The suite of nutrient water quality targets for East Boulder River segments MT43B004_141 and MT43B004_142 is given in table 4-11. It is important to note that the chlorophyll-a criteria of 50 mg/m^2 is the primary nutrient target for the East Boulder River, as it is a direct measure of increasing nutrient levels that would impact beneficial uses. Nutrient targets for NO_3+NO_2, TP and TN are established at concentrations believed to control nuisance algal growth and should be considered secondary targets where adequate chlorophyll-a data exists. Where chlorophyll-a data does not exist, nutrient targets will provide the basis for evaluating target compliance. Consequently, target compliance shall be focused mainly on maintaining chlorophyll-a levels below 50 mg/m^2, and can be achieved by controlling duration and frequency of nutrient concentrations at or below target values.

Table 4-11. Nutrient targets for East Boulder River segments MT43B004_141 and MT43B004_142

Target Indicator	Target Value
Chl-a	**<50 mg/m^2**
NO_3+NO_2	<0.08 mg/L
Total Phosphorus (TP)	<0.02 mg/L
Total Nitrogen (TN)	<0.38 mg/L

4.4.3 Water Quality Targets Evaluation

Nutrient target indicator data (chlorophyll-a, NO_3+NO_2, total nitrogen, total phosphorus) is available at several locations (EBR-006 through EBR-009) on impaired segments MT43B004_141 and MT43B004_142 (figure 4-11). In this section, data collected at these sites is compared to the East Boulder River nutrient targets in table 4-11, followed by a determination of whether East Boulder River segments MT43B004_141 and MT43B004_142 are impaired for chlorophyll-a.

4.4.3.1 Data Results

Water Chemistry: NO_3+NO_2, Total Nitrogen, Total Phosphorus
Water chemistry data was collected at sites EBR-006 through EBR-009 from 2000 through 2004. Summer growing season (July 16th – Sept 30th) values are given in table 4-12. Exceedances of the target values are marked in **bold,** and potential outliers in **red.** *For purposes of simple analysis, outliers are assumed to be greater than three standards deviations from the mean, and were included in summary statistical analysis results given in table 4-13.*

Table 4-12. Summer nutrient data for East Boulder River segments, MT43B004_141 and MT43B004_142

Sample Site	Sample Date	NO_3 + NO_2	Total Nitrogen	Total Phosphorus
EBR-006	08/28/00	0.005		0.013
EBR-006	08/29/01	0.040	0.240	0.018
EBR-006	08/27/02	0.050	0.250	0.004
EBR-006	09/10/03	0.060	0.100	0.017
EBR-006	8/15/2005	0.080	0.380	0.020

Table 4-12. Summer nutrient data for East Boulder River segments, MT43B004_141 and MT43B004_142

Sample Site	Sample Date	$NO_3 + NO_2$	Total Nitrogen	Total Phosphorus
EBR-007	08/28/00	0.050		0.015
EBR-007	08/29/01	0.030	0.230	0.017
EBR-007	08/27/02	0.040	**0.740**	0.005
EBR-007	09/10/03	0.050	0.200	0.016
EBR-007	08/28/04	0.040	0.200	0.014
EBR-007	08/28/04	0.040	0.200	0.013
EBR-007	8/15/2005	0.080	0.380	0.020
EBR-008	08/28/00	0.020		0.010
EBR-008	08/29/01	0.005	0.210	0.017
EBR-008	08/27/02	0.005	0.210	0.042
EBR-008	09/10/03	0.020	0.100	0.017
EBR-008	08/28/04	0.005	0.300	0.015
EBR-008	8/15/2005	0.010	**0.410**	0.020
EBR-009	08/28/00	0.060		0.013
EBR-009	08/29/01	0.180	**0.480**	0.017
EBR-009	08/27/02	0.030	0.030	0.005
EBR-009	09/10/03	0.005	0.200	0.018
EBR-009	8/15/2005	0.040	**0.440**	0.020

Table 4-13. Statistical summary of East Boulder River nutrient data

	$NO_3 + NO_2$ (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
min	0.005	0.030	0.004
max	0.180	0.740	0.042
median	**0.040**	**0.230**	**0.017**
75th %ile	**0.050**	**0.380**	**0.018**

Chlorophyll-a

Chlorophyll-a data was collected at sites EBR-006 through EBR-009 from 2000 through 2005. From 2000 through 2004, 10 to 15 replicate chlorophyll-a samples were collected at each site during each sampling event. In 2005, only a single sample was collected at each site. Figure 4-10 shows mean chlorophyll-a densities at each sampling location.

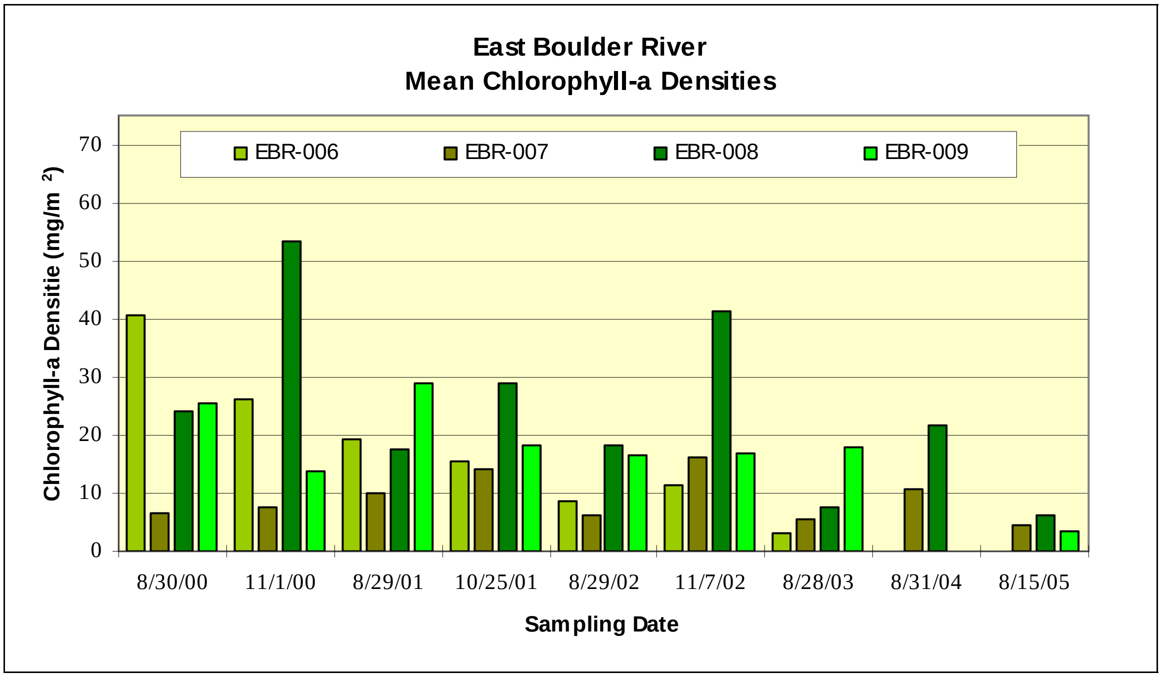

Figure 4-10. Mean chlorophyll-a densities, East Bolder River 2000-2005

Table 4-14. Statistical summary of East Boulder River chlorophyll-a data

	Chlorophyll-a density (mg/m^2)
min	0.1
max	53.3
mean	16.6
75th %ile	**20.9**

4.4.3.2 Data Discussion and Impairment Summary

In order to evaluate whether "*conditions which will produce undesirable aquatic life*" are present in the East Boulder River, both water chemistry data and chlorophyll-a data was considered. While some nutrient values exceeded target criteria, as might be expected in any large data set, the majority of the data was below nutrient target values presented in table 4-11. When medians and 75th percentiles (table 4-13) were compared to nutrient target values, all median values were below targets and the TN 75th percentile was at the target value of 0.38 mg/L. Chlorophyll-a data summaries (table 4-14) verify that nutrient concentrations are below levels thought to cause impairment of surface waters from algal growth. Of 33 composite chlorophyll-a sample means taken over a 5 year period, a single sample mean (53 mg/m^2) exceeded the target criteria of 50 mg/m^2.

Previous chlorophyll-a impairment listings on segments MT43B004_141 and MT43B004_142 were based on incorrect chlorophyll-a density calculations. Data used for past impairment determination were not corrected for algal sample size templates and therefore previous concentrations were recorded as significantly higher than actual values.

Table 4-15. TMDL nutrient target evaluation summary for East Boulder River

Target Indicator	Target Value	Existing Conditions	Target Evaluation
$NO_3 + NO_2$	<0.08 mg/L	Median = 0.040 mg/L 75th %ile = 0.050 mg/L	Meeting target
Total Nitrogen	<0.38 mg/L	Median = 0.230 mg/L 75th %ile = 0.380 mg/L	Median meeting target 75th %ile at target
Total Phosphorus	<0.02 mg/L	Median = 0.017 mg/L 75th %ile = 0.018mg/L	Meeting target
Chlorophyll-a	<50 mg/m2	Mean = 16.6 mg/m^2 75th %ile = 20.9 mg/m^2	Meeting target

Data review and evaluation shows that water quality targets for nutrients and chlorophyll-a in East Boulder River segments MT43B004_141 and MT43B004_142 are being met. Compliance with nutrient targets ($NO_3 + NO_2$, total nitrogen and total phosphorus) was based on whether the majority of nutrient water quality data met target criteria. In nutrient data sets, data distribution is such that periodic high values are expected and are not cause for alarm. In this case, the 75th percentile was chosen to represent the majority of data. Using the 75th percentile rather than the mean or median nutrient concentration is protective of existing water quality and provides a margin of safety when evaluating potential impacts to beneficial uses. As reported in table 4-15, 75th percentiles for $NO_3 + NO_2$, total phosphorus and chlorophyll-a are meeting targets. The 75th percentile of TN (0.38 mg/L) was at the target value, however chlorophyll-a response shows that resultant algal densities remain well below target values. The chlorophyll-a target of <50 mg/m^{2}was exceeded once in 33 composite samples, or 3% of samples. Average chlorophyll-a concentration at all sites in the impaired segments was 16.6 mg/m^2, a strong indicator that chlorophyll-a is not impairing beneficial uses in the East Boulder River. **Existing data evaluation supports the decision that the East Boulder River, segments MT43B004_141 and MT43B004_142, are not impaired for chlorophyll-a as was previously reported, and TMDLs are not required.**

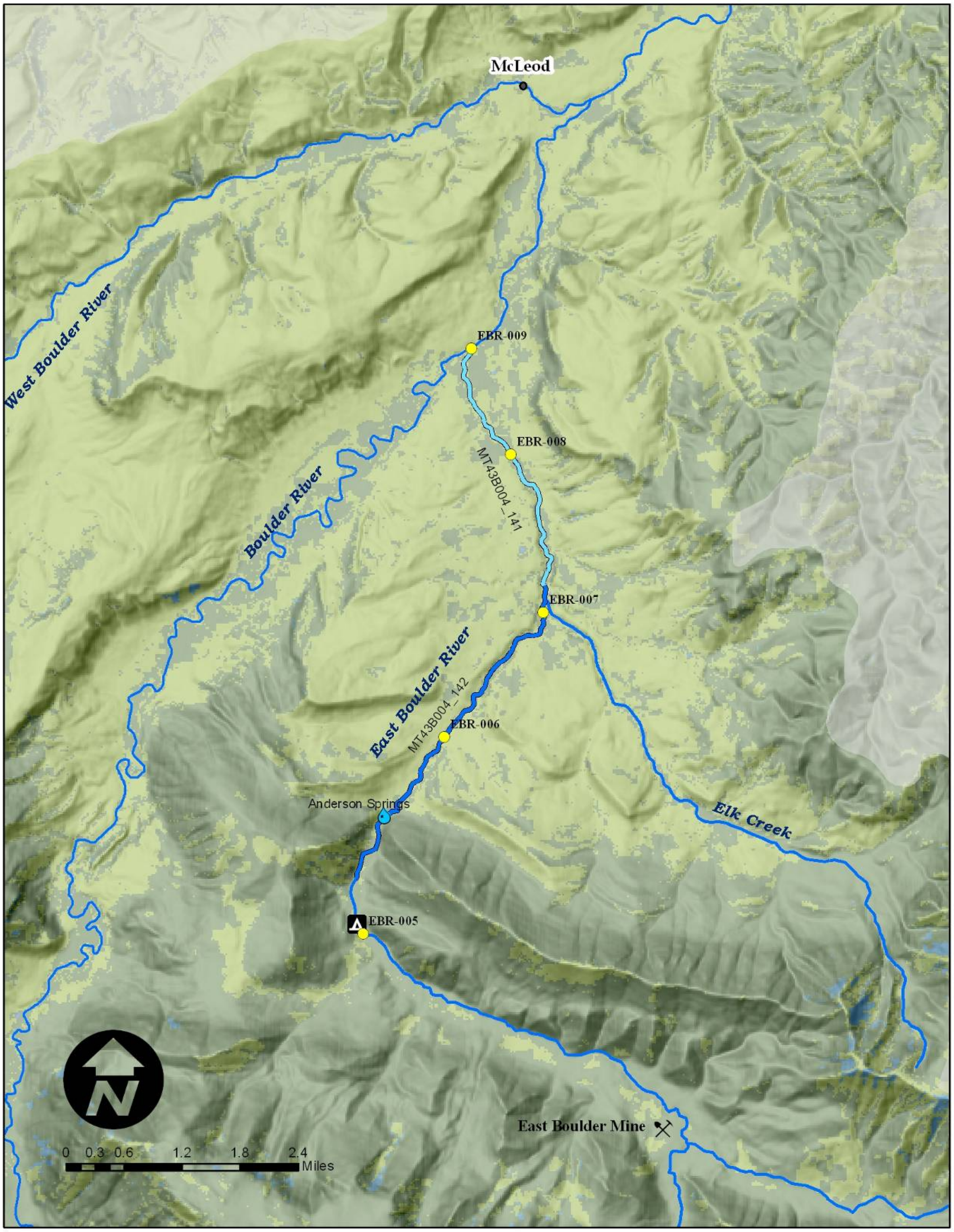

Figure 4-11. East Boulder River sampling sites

4.4.4 Further Issues, Concerns & Recommendations

4.4.4.1 Tributaries and Low Flows

Tributaries to the East Boulder River can influence water quality, particularly when the East Boulder River is at low flows. At low flows, water temperatures are generally warmer and elevated nitrogen and phosphorus loads entering from tributary sources have a greater potential to reach higher instream concentrations and may result in nuisance algal growth.

One major tributary to the East Boulder River, Elk Creek, exhibits an average summertime total nitrogen concentration of 0.34 mg/L and a total phosphorus concentration of 0.039 mg/L. In a phosphorus-limited stream such as the East Boulder River, small increases in phosphorus loads can lead to conditions that cause excessive growths of algae, particularly in periods of low-flow during summer months. While existing chlorophyll-a data indicates that algae are currently below levels thought to cause impairment, working to augment and maintaining instream flows during critical low-flow periods will ensure nutrient and chlorophyll-a conditions in the East Boulder River will not impair beneficial uses. Avoiding low flow conditions will also provide habitat benefits for fish and associated aquatic life and assist in maintaining adequate substrate conditions for the propagation of fishery resources.

4.4.4.2 East Boulder Mine

The East Boulder Mine is located on the East Boulder River, segment MT43B004_143 (figure 4-12). The East Boulder Mine is authorized through the Montana Pollutant Discharge Elimination System (MPDES) to discharge unaltered ground water and treated wastewater to ground water in alluvial sediments adjacent to the East Boulder River (permit no. MT-0026808). Daily maximum load limits for total nitrogen are 45 lbs/day (with an *average annual load limit* of 32 lbs/day), and 77 lbs/day in June if instream flow is >22 cfs. These load limits are based on the findings of the FEIS that determined than an instream nitrogen increase of 1 mg/L was nonsignificant according to Montana’s nondegradation rules [ARM 17.30.715(1)(c) and (3)].

Since the FEIS determination, DEQ has placed considerable effort in developing numeric nutrient water quality criteria designed to provide interpretation of Montana’s narrative nutrient standard for the protection of aquatic life and recreational uses. If one follows the process to develop in-stream water quality criteria for nutrients as defined in Section 4.4.2 Targets, reference water quality criteria for the East Boulder River at the mine site are in the range 0.38 to 0.42 mg/L for total nitrogen. Based on these criteria, a load of 45 lbs/day to this segment would exceed the maximum allowable load required to maintain recreational and aquatic life beneficial uses.

The existing allowable nitrogen load limits in permit no MT-0026808, <u>if realized instream</u>, would cause water quality criteria for nitrogen to be exceeded, and would therefore be cause for impairment listing of segment MT43B004_143. Once impairment is verified, TMDLs would be developed and a waste load allocation to the mine would be calculated. As there is no present impairment to the segment, and to date ground water discharges do not seem to be impacting surface waters, DEQ does not proposing any changes in mining operations, but recommends that these issues be considered in any future MPDES permits at the discretion of the Water Quality Permitting Section at DEQ.

The wastewater discharge is to ground water rather than a direct discharge to surface waters, making it difficult to monitor and estimate nitrogen loading to surface waters. At present, extensive DEQ data sets for instream nutrient water chemistry and biology (chlorophyll-a, macroinvertebrates, periphyton) indicate that segment MT43B004_143 is fully supporting its beneficial uses, and that in-stream nitrogen levels do not appear to be elevated above naturally occurring levels. However, monitoring of nitrate levels in ground water downgradient of the East Boulder Mine's ground water discharge point shows an increasing trend in NO3 + NO2 concentrations from 2000 through 2005 (figures 4-12 and 4-13), suggesting the potential for ground water to impact surface waters in the future.

DEQ recommends the following actions in order to assess potential impacts to surface waters from ground water nitrate loading:

- Continue monitoring of ground water nitrate concentrations at established monitoring wells, EBMW-2, EBMW-3, EBMW-6, EBMW-7, EBMW-8 and EBMW-9 and at surface water monitoring locations EBR-003 and EBR-004 as stipulated in permit no. MT-0026808.
- Continued biological monitoring in accordance with the *Biological Monitoring Plan for Stillwater Mining Company – East Boulder Project* (1998) as stipulated in permit no. MT-0026808.
- Conduct an assessment of stream segment MT43B004_143 to determine whether a ground water recharge zone exists downstream from stream sampling site EBR-004.
- Establish a secondary surface water monitoring station between sampling site EBR-004 and EBR-005, downstream from any ground water recharge zone. Sample quarterly for nutrients and annually (late summer) for macroinvertebrates and chlorophyll-a.
- Quarterly nutrient sampling and annual macroinvertebrate and chlorophyll-a (late summer) at surface water monitoring station EBR-005.

Figure 4-12. East Boulder Mine surface water and ground water monitoring sites

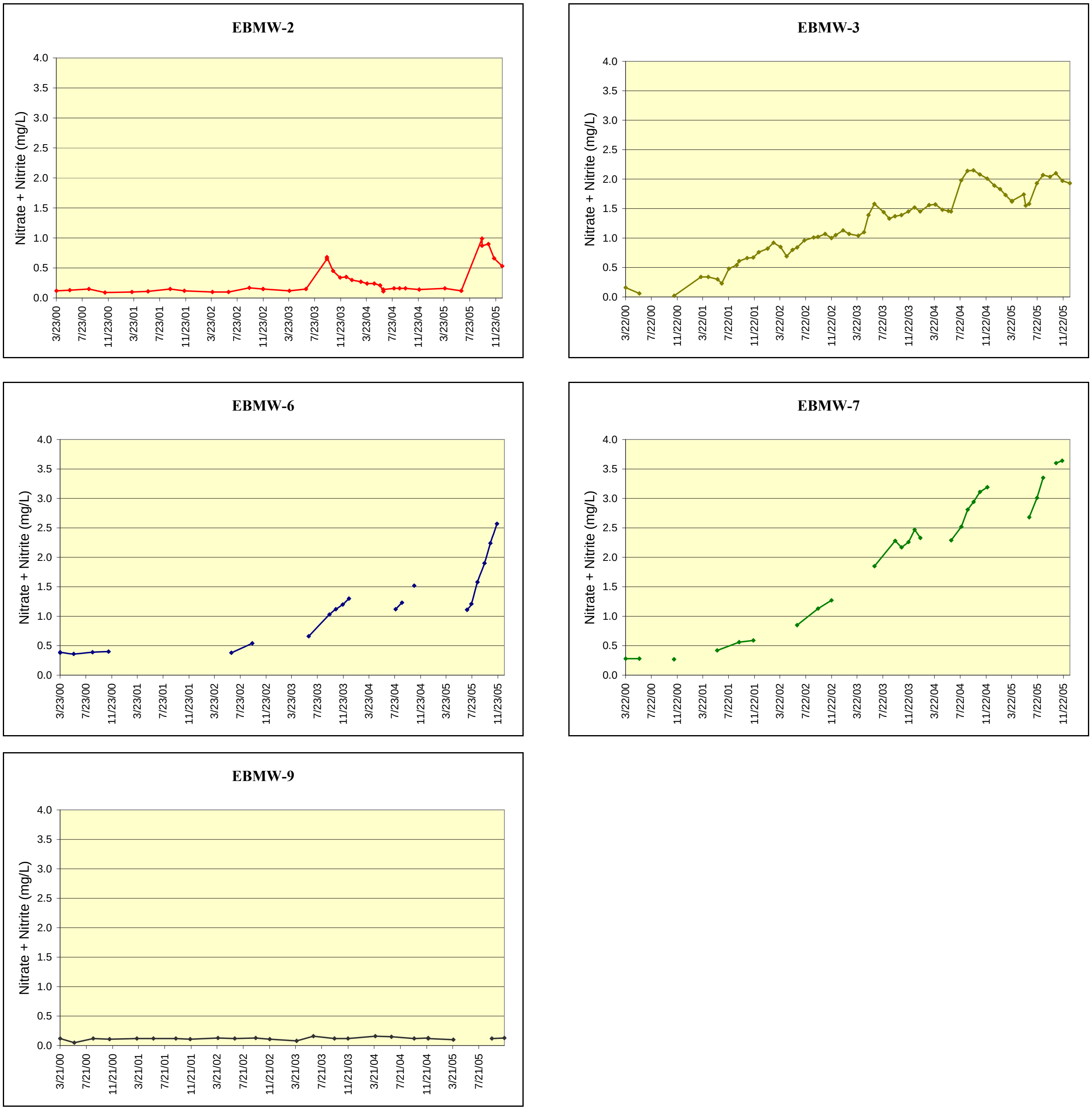

Figure 4-13. Ground water nitrate + nitrite (NO_3 + NO_2) trends 2000-2005, East Boulder Mine

4.4.4.3 Didymosphenia geminata in the upper East Boulder River

Biological monitoring on East Boulder River segment MT43B004_143 has been conducted from 1998 through the present at monitoring sites, EBR-004, EBR-003, and EBR-002(figure 4-12) for regulatory compliance related to the East Boulder Mine’s MPDES permit. Recent observations and bioassessments recorded a dramatic increase in diatom biomass at monitoring sites EBR-002, EBR-003 and EBR-004. During 2004, the diatom *Didymosphenia geminata* exhibited 80-100 percent coverage of stream bottom substrates (figure 4-14), EBR-003 and EBR-004 whereas in previous bioassessments (1998-2003), coverage of *D. geminata* was limited to less than 5 percent coverage. Presently, D. geminata coverage remains excessive and appears to be increasing at upstream sampling site EBR-001 (Zuzulock, Beeson, 2006 personal communication).

Figure 4-14. *D. geminata* coverage at EBR-002, September 2004

Figure 4-15. *D. geminata* coverage at EBR-004, September 2004

Proliferation of *D. geminata* is not an isolated occurrence in the East Boulder River, as this organism appears to be expanding its geographic range and forming excessive growths in many North American streams and rivers. Excessive *D. geminata* growths have the potential to impact habitat for fish, aquatic plants, and insects. The mechanism underlying the recent proliferation of *D. geminata* is not fully understood in the East Boulder River or elsewhere.

The presence of *D. geminata* in the East Boulder River confounds interpretation and evaluation of water quality and biological samples taken in the upper reaches (EBR-001 through EBR-004) of the East Boulder River. Because the mechanisms underlying *D. geminata* proliferation are not fully understood, it is unknown whether this condition will persist in future years. Monitoring recommendations provided in Section 4.4.4.2 should be sufficient to address data needs to evaluate influences of *D. geminata* on existing nutrient and biological sampling activities. As data and information increases our knowledge and understanding of this phenomena, DEQ will reevaluate the condition of the upper Boulder River with respect to beneficial use determinations through the Department's process of defining beneficial use impairments (appendix A, 2006 Integrated Report).

4.5 Boulder River Metals Assessment (Segments MT43B004_131, MT43B004_132, MT43B004_133, MT43B004_134, MT43B005_010)

The 2006 303(d) list status of water bodies in the Boulder River TPA is summarized in Section 3.0. Boulder River segments MT43B004_131, MT43B004_132, and MT43B004_134 are listed as impaired for metals (copper, lead, chromium, nickel, silver, iron): aquatic life, cold-water fisheries and drinking water are the beneficial uses that have been identified as not fully supported due to these impairment conditions.

Section 4.5 provides an assessment of metals sources, metals water quality targets, and an evaluation of existing conditions and data with respect to water quality targets for segments MT43B004_131, MT43B004_132, MT43B004_133, and MT43B004_134. In addition to these segments, Basin Creek segment MT43B005-010 is evaluated. Basin Creek lies at the headwaters of the Boulder River and is a known source of abandoned mine lands that contribute metals loads to the Boulder River. Section 4.5 concludes with a determination of whether segments are impaired for metals and consequent TMDL development.

4.5.1 Metals Sources

Sources of metals in the Boulder River include nonpoint sources (natural geologic sources & historic mining sites), and point sources (permitted discharges from the East Boulder Mine). Additional nonpoint sources may include downstream channel and streambank/floodplain deposits where historical mining has elevated metals concentrations.

Natural sources of metals are those that contribute metals independently of human disturbance or influence. Natural sources are geologically derived from metals found within the Earth's crust. The geology throughout the watershed is mineral rich and has the potential to contribute metals to receiving waters through natural weathering processes. **Abandoned mines** have a large potential to affect receiving water quality through non-point source loading. Lands surrounding abandoned mines often contain exposed mineral deposits, mine dumps, adit discharges and tailings that can contaminate the surrounding watershed and ecosystem. There are a number of known abandoned mines within the Boulder River watershed. Although the total number of mines is fairly large, State priority abandoned mine sites in the basin are limited to the Independence Mining District, and the Basin Creek sub-basin. **Channel and streambank/floodplain** deposits can harbor higher levels of metals, as loads from upstream abandoned mine source areas move their way downstream through the river system. High flows may remobilize these sediment-metals through bank erosion and channel scouring and contribute to water quality impairment. **Permitted discharges** through the state's MPDES Permitting Program may contribute metals to surface water. Load limits defined in the MPDES permit are designed to maintain water quality standards.

4.5.2 Metals Water Quality Targets

For pollutants with numeric standards (metals), the established state numeric standard as defined in DEQ Circular DEQ-7 is typically adopted as the water quality target. Numeric standards apply to both human health and aquatic life protection. To ensure protection of all uses, the lowest applicable numeric standard is used as the target: in this case, the chronic aquatic life standard is the lowest applicable numeric standard. The numeric aquatic life standards for most metals are calculated based on hardness values: as hardness increases, the water quality standard for a specific metal increases also. Consequently, where the aquatic life numeric standard is used as the target, the target values for specific metals will vary according to the water hardness. Water quality standards (acute[1] and chronic aquatic[2] life, human health) for each parameter of concern at a water hardness of 25 mg/L are shown in Table 4-16.

Table 4-16. Water quality standards for metals at 25 mg/L hardness

Parameter	Aquatic Life Standard (ug/L)		Human Health Standard (ug/L)	
	Acute	Chronic	Surface Water	Ground Water
Cadmium	0.52	0.097	5	5
Chromium	579	27.7	100	100
Copper	3.79	2.85	1,300	1,300
Lead	13.98	0.545	15	15
Nickel	145	16.1	100	100
Silver	0.374	NA	100	100
Zinc	37	37	2,000	2,000
Iron	1000	1000	*3	*3

The water quality target for metals is the chronic aquatic life standard. Water quality that is maintained below the chronic aquatic life standard is protective of aquatic life uses and human health, and affords a margin of safety to protection of aquatic life uses. Compliance with chronic aquatic life standards are based on an average water quality concentration over a 96 hour period. Because data is limited and typically consists of a single water quality sample, rather than a time-series, single samples are assumed to represent the 96-hour average concentration. In the case of silver, which does not have a chronic standard, the acute standard is the target value. Because water quality standards for most metals vary according to water hardness, actual target values are a function of measured water hardness at the time of sampling. Metals water quality targets are given in table 4-17 for two hardness conditions that represent potential conditions within the Boulder River.

Table 4-17. Metals water quality targets for the Boulder River TMDL Planning Area (values in ug/L)

Parameter	Water Quality Target at 25 mg/L harness (high flow)	Water Quality Target at 100 mg/L harness (low flow)
Cadmium	0.097	0.27
Chromium	27.7	86
Copper	2.85	9.3
Lead	0.545	3.2

[1] No surface or ground water sample concentration shall exceed these values
[2] No surface or ground water average concentration shall exceed these values based upon a 4-day (96 hr) or longer period.
[3] The concentration of iron must not reach values that interfere with the uses specified in the surface and groundwater standards (17.30.601 et seq. and 17.30.1001 et seq) (DEQ, 2006))

Table 4-17. Metals water quality targets for the Boulder River TMDL Planning Area (values in ug/L)

Parameter	Water Quality Target at 25 mg/L harness (high flow)	Water Quality Target at 100 mg/L harness (low flow)
Nickel	16.1	52
Silver	0.374	4.1
Zinc	37	120
Iron	1000	1000

Stream sediment data may also be indicative of impairment caused by elevated metals and are used as supplementary indicators of impairment. In addition to directly impairing aquatic life that interacts with the elevated metals in the sediment, the elevated sediment values can also be an indicator of elevated concentrations of metals during runoff conditions. This can be a particularly important supplemental indicator when high flow data is lacking.

The National Oceanic and Atmospheric Administration (NOAA) has developed Screening Quick Reference Tables for stream sediment quality, and gives metals concentration guidelines for freshwater sediments. Screening criteria concentrations come from a variety of studies and investigations, and are expressed in Threshold Effects Levels **(TEL)** and Probable Effects Levels **(PEL)**. TELs represent the sediment concentration below which toxic effects to aquatic life occur rarely, and are calculated as the geometric mean of the 15th percentile concentration of the toxic effects data set and the median of the no-effect data set. PELs represent the sediment concentration above which toxic effects frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects data set and the 85th percentile of the no-effect data set.

The state of Montana does not currently have criteria that define impairment condition based on sediment quality data, however general water quality prohibitions given in Table 3-5 state that *"state surface waters must be free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life."* TELs and PELs provide a screening tool that may assist in identification of *the presence of* toxic substances, and can be used to assist in impairment determinations where water chemistry data is limited.

Table 4-18 contains the TEL and PEL values (in parts per million) for parameters of concern in the Boulder TPA.

Table 4-18. Screening level criteria for sediment metals concentrations (NOAA, 1999)

Metal of Concern	TEL (ppm)	PEL (ppm)
Cadmium	0.596	3.53
Chromium	37.3	90
Copper	35.7	197
Lead	35	91
Nickel	18	36

Table 4-18. Screening level criteria for sediment metals concentrations (NOAA, 1999)

Metal of Concern	TEL (ppm)	PEL (ppm)
Silver	NA	NA
Zinc	123	315

4.5.3 Water Quality Targets Evaluation

Metals indicator data (water quality and sediment samples) are available at several locations in Boulder River Segments MT43B004_131, MT43B004_132, MT43B004_133, and MT43B004_134 (Figure 4-16). In this section, data collected at these sites is compared to the Boulder River metals targets established in Section 4.5.2, followed by a determination of whether Boulder River segments are impaired for metals.

Impairment determination is based on the following assumptions:

- Natural levels of metals are below the chronic water quality criteria for aquatic life under all flow conditions.
- Single water quality samples represent a 96-hour average water quality concentration.

Data utilized in evaluating compliance with water quality targets consisted of water quality data collected since 1993, including additional data that was collected in 2004 and 2005 that was not readily available when making impairment determinations for the 2006 303(d) List. Historical data collected primarily in the 1970s and early 1980s was not considered due to data quality and reliability concerns (reporting limits, collection, analysis and recording methods) and because older data may not adequately characterize existing conditions.

Where there is any exceedance of the numeric standard (target) a TMDL is developed. If there are no recent exceedances of a numeric standard, but there is insufficient data to fully evaluate all seasonal flow conditions, then TMDL development may not be pursued within this document, and a framework sampling plan is presented to obtain additional data to better define water quality conditions for making updated impairment determinations.

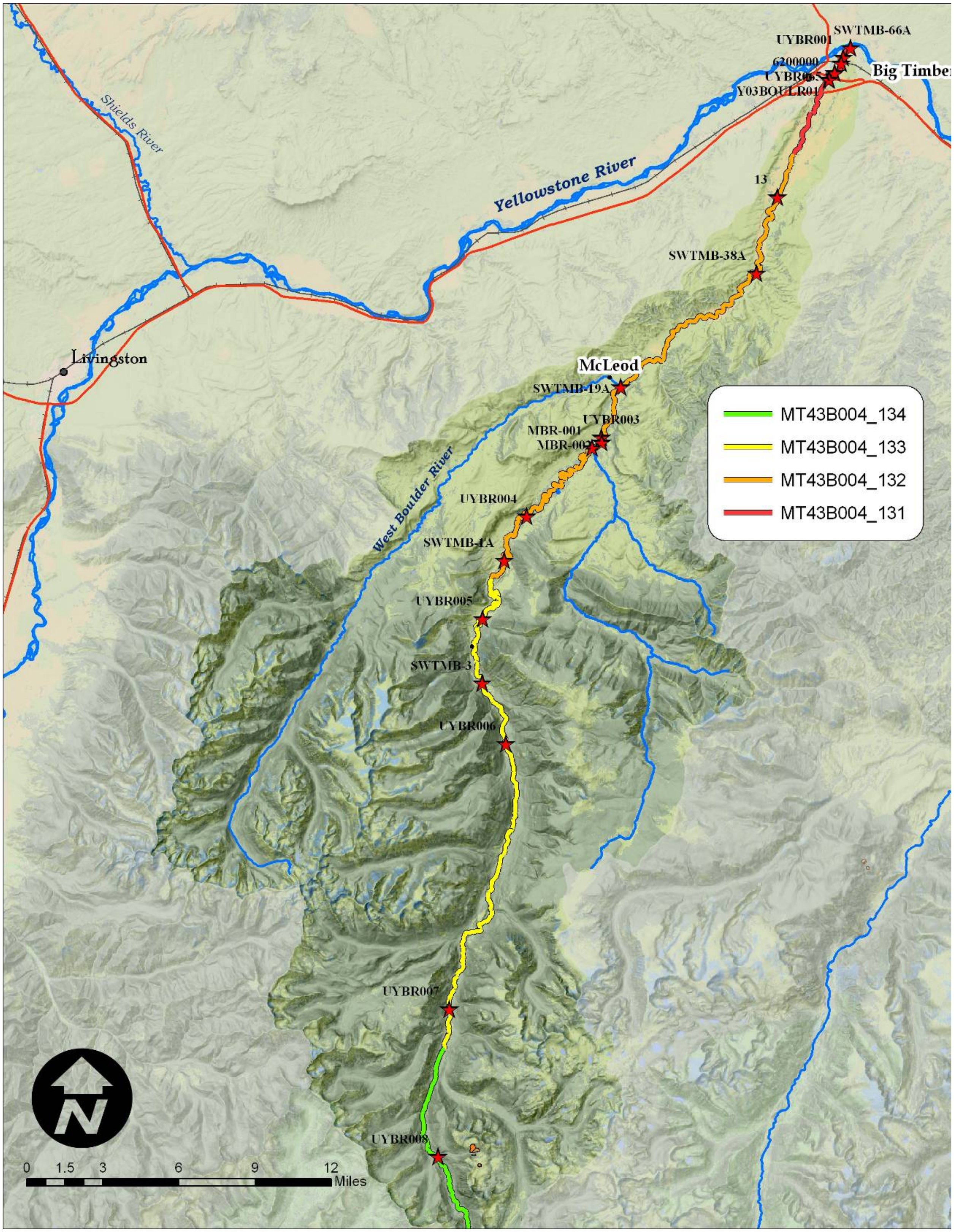

Figure 4-16. Boulder River metals sampling locations (1992-2006)

4.5.3.1 Boulder River Segment MT43B004_131

The 2006 303(d) list identifies Boulder River Segment MT43B004_131 as impaired due to metals: lead, copper, silver and iron.

Water Quality Data Results
Water quality metals samples from segment MT43B004_131 have been collected primarily by the USGS and DEQ, and are given in table 4-20. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality standard for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Underlined values are the associated water quality target, with hardness adjustments where necessary. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

Lead and **copper** exceed the water quality target on four separate sampling events. Each target exceedance occurred during high seasonal flows (May and June) at flows at or above 1500cfs. There were no exceedances at flows lower than 1000 cfs.

Impairment determinations for silver and iron are based on older data that shows some exceedances of the water quality standards. There were no exceedances of **silver** or **iron** in the more recent data set presented in Table 4-20. June 2004 data indicates increased iron levels at higher seasonal flows (<1000 cfs), however silver and iron data was not available for high-flow sampling events (>1500 cfs) when lead and copper exceedances were observed.

Sediment Quality Data Results
Sediment quality data is limited (Table 4-19), and showed no exceedances of copper, lead, or silver above Threshold Effects Levels (TELs). Both chromium and nickel sediment levels were slightly elevated above TELs, however no water quality exceedances of chromium or nickel were observed.

Table 4-19. Sediment water quality metals data, Boulder River segment MT43B004_131

Station ID	Date	Copper (ppm)			Lead (ppm)			Silver (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR001	8/13/99	13	35.7	197	7	35	91	ND	0.733	1.77
Y03BOULR01	7/24/01	22	35.7	197	15	35	91	ND	0.733	1.77

Data Discussion
At high flows, lead and copper exceeded water quality targets. Iron and silver data did not exceed water quality targets using more recent data, and copper, lead and silver do not appear to be at elevated levels in stream sediments. Iron and silver concentrations were not available for the same sampling events when lead and copper exceedances were observed. High seasonal flows (late may through june) correlate with increased levels of most metals, suggesting runoff and stream channel sources as potential contributors. It is possible that at flows higher than 1500 cfs, some additional metals concentrations may exceed water quality targets, but only copper and lead exceedances have been verified thus far.

Conclusion

Recent copper and lead concentrations show several water quality exceedances, verifying that **Boulder River segment MT43B004_131 is impaired from elevated copper and lead levels**. The impairment determination listing iron and silver as causes of impairment for Boulder River segment MT43B004_131 was based on data over 20 years old. Newer more accurate data do not demonstrate impairment from silver or iron, although representative high flow data is lacking in the more recent data sets. Because there are no recent exceedances of the numeric water quality standard, TMDLs will not be developed for either iron or silver along this segment of the Boulder River at this time. Additional sampling should be conducted, particularly at flows > 1500 cfs to better define impairment conditions and facilitate future TMDL development for these metals. **Copper and lead TMDLs will be developed for Boulder River segment MT43B004_131.**

Table 4-20. Water quality metals data, Boulder River segment MT43B004_131

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
SWTMB-66A	10/02/03	72	<1	11.9	18.4	<1	4.6	118				20	1000	
UYBR001	05/25/04	~398	1.0	6.8	9.8	2	2.0	51	<1		2.1	50	1000	
UYBR001	06/04/04	~855	2.0	5.1	7.2	<1	1.3	34	<1		1.2	590	1000	
14	08/13/99		1.0	7.7	11.3	<2	2.4	61	<3		2.7	110	1000	
UYBR065A	09/03/04		1.0	12.1	18.6	<2	4.7	120	<1		6.8	20	1000	
6200000	06/17/99	3,780	**5.3**	3.1	4.2	**1.7**	0.6	16						
6200000	08/17/99	312	<1	8.8	13.1	<1	2.9	74						
6200000	11/04/99	141	0.7	11.7	17.9	<1	4.4	114						
6200000	05/31/00	2,130	2.2	3.4	4.6	<1	0.7	18						
6200000	05/16/01	2,050	**7.2**	3.0	4.1	**1.44**	0.6	15						
6200000	08/23/01	17	0.7	12.5	19.4	<1	4.9	126						
6200000	10/25/01	110	1.0	11.7	17.9	<1	4.4	114						
6200000	05/22/02	1,510	**5.5**	3.3	4.5	**1.14**	0.7	18						
6200000	05/21/03	591	1.0	7.0	10.1	0.13	2.1	53						
6200000	07/29/03	233	0.6	9.7	14.7	<0.06	3.4	87						
6200000	10/02/03	75	<1	12.0	18.4	<2	4.6	118	<3		6.7			
Y03BOULR01	06/24/04	1,500	1.0	4.0	5.5	**1.00**	0.9	23	<1		0.7	540	1000	
Y03BOULR01	07/16/05	700	<1	6.1	8.8	ND	1.7	43	<1		1.7	80	1000	

Table 4-20: Water quality metals data, Boulder River segment MT43B004_131 (cont)

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Nickel (µg/L)			Zinc (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
SWTMB-66A	10/02/03	72	<0.1	0.34	2.86	<1	109	2,286	<10	67	599	<10	153	153
UYBR001	05/25/04	~398	<0.1	0.21	1.46	<1	63	1,327	<10	38	342	<1	87	87
UYBR001	06/04/04	~855	<0.1	0.16	1.05	2	49	1,017	<10	29	260	<1	66	66
14	08/13/99		<0.1	0.23	1.69	2	71	1,496	<10	43	387	<10	99	99
UYBR065A	09/03/04		<0.1	0.34	2.89	<1	110	2,305	<10	67	605	<10	155	155
6200000	06/17/99	3,780	**<1**	0.11	0.58	6	30	636	6.50	18	160	<40	41	41
6200000	08/17/99	312	**<1**	0.26	1.98	<1	81	1,699	<1	49	441	<40	113	113
6200000	11/04/99	141	<0.1	0.33	2.79	<1	107	2,235	<1.8	65	586	<31	150	150
6200000	05/31/00	2,130	<0.1	0.11	0.65	2	33	691	1.14	19	174	4	44	44
6200000	05/16/01	2,050	<0.1	0.10	0.56	2	29	617	2.06	17	155	4	40	40
6200000	08/23/01	17	<0.1	0.35	3.02	<1	114	2,389	<1	70	627	<1	160	160
6200000	10/25/01	110	<0.1	0.33	2.79	<1	107	2,235	<1	65	586	1	150	150
6200000	05/22/02	1,510	<0.1	0.11	0.63	2	32	673	2.44	19	169	4	43	43
6200000	05/21/03	591	<0.2	0.21	1.51	1	65	1,362	0.71	39	351	3	90	90
6200000	07/29/03	233	<0.04	0.28	2.24	<1	90	1,877	0.78	54	489	<2	125	125
6200000	10/02/03	75	<0.1	0.34	2.87				<10	67	600	<10	153	153
Y03BOULR01	06/24/04	1,500	<0.1	0.13	0.78	2	38	804	ND	23	204	2	52	52
Y03BOULR01	07/16/05	700	<0.1	0.19	1.29	<1	57	1,201	ND	34	308	1	79	79

4.5.3.2 Boulder River Segment MT43B004_132

The 2006 303(d) list identifies Boulder River Segment MT43B004_132 as impaired due to two metals: nickel, chromium.

Water Quality Data Results
Water quality metals samples from segment MT43B004_132 have been collected primarily by the USGS and DEQ, and are given in table 4-22. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality standard for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Underlined values are the associated water quality target, with hardness adjustments incorporated. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

The only exceedances of water quality targets occurred for iron during spring runoff flows. On 6/03/03 iron concentrations at sampling sites MBR-001 and MBR-002 exceeded the water quality target of 1000 ug/L. Flows were not recorded on this data, but it is assumed that samples were collected during high flows associated with runoff conditions.

Sediment Quality Data Results
Sediment quality data is limited, however data did reveal some sediment metals concentrations elevated above TELs (Table 4-21). One of three sediment samples contained elevated levels of chromium, and two of three contained levels of nickel above TELs.

Table 4-21. Sediment water quality metals data, Boulder River segment MT43B004_132

		Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
Station ID	**Date**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR003	8/13/99	ND	0.60	3.53	49	37	90	11	35.7	197
UYBR004	8/13/99	ND	0.60	3.53	30	37	90	9	35.7	197
13	8/13/99	ND	0.60	3.53	26	37	90	11	35.7	197
		Lead (ppm)			**Nickel (ppm)**			**Silver (ppm)**		
Station ID	**Date**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR003	8/13/99	6	35	91	27	18	36	ND	0.733	1.77
UYBR004	8/13/99	ND	35	91	19	18	36	ND	0.733	1.77
13	8/13/99	ND	35	91	16	18	36	ND	0.733	1.77

Data Discussion
At low flows, metals concentrations in water quality samples were either at very low concentrations or were undetectable. At seasonal runoff flows (May, June), metals levels increased but were predominantly below target values. The exception occurred at sampling sites **MBR-001 and MBR-002 where iron exceeded the target of 1,000 ug/L on 06/03/03.**

While sediment metals concentrations for chromium and nickel were elevated above the TEL, no water quality target exceedances of these metals was observed. During seasonal runoff flows, elevated chromium levels were observed but remained significantly below the water quality target; no detects for nickel were observed in any of the water quality samples collected.

Conclusion

Recent water quality data show water quality exceedances of iron, demonstrating that **Boulder River segment MT43B004_132 is impaired from elevated iron levels. Iron TMDL will be developed for Boulder River segment MT43B004_132.** There were no exceedances of water quality targets for chromium or nickel. Additional sediment and water quality assessments should be conducted, particularly at flows > 1500 cfs, to further characterize impairment conditions and facilitate future TMDL development for these metals.

Table 4-22. Water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
13	08/13/99		1.0	6.7	9.7	**<2**	1.9	50	**<3**	N/A	2.1	160	1000	
SWTMB-38A	10/01/03	70	<1	10.9	16.6	<1	4.0	102	<1	N/A	5.5	<10	1000	
UYBR002	05/25/04		1.0	6.2	8.9	<1	1.7	45	<1	N/A	1.8	50	1000	
UYBR002	06/04/04		2.0	4.4	6.2	<1	1.1	27	**<1**	N/A	0.9	490	1000	
SWTMB-19A	08/15/03	130	<1	9.0	13.4	<1	3.0	77	<1	N/A	3.7	20	1000	
SWTMB-19A	10/01/03	73	<1	11.0	16.8	<1	4.1	104	<1	N/A	5.6	20	1000	
SWTMB-19A	09/03/04		<1	9.5	14.3	<2	3.3	84	<1	N/A	4.2			
12	08/13/99		1.0	5.1	7.1	**<2**	1.3	33	**<3**	N/A	1.2	280	1000	
UYBR003	05/25/04		1.0	5.0	7.0	<1	1.2	32	<1	N/A	1.1	70	1000	
UYBR003	06/04/04		2.0	4.1	5.7	**<1**	0.9	24	**<1**	N/A	0.8	170	1000	
MBR-002	08/28/00		<1	9.3	14.0	<3	3.2	82				20	1000	
MBR-002	10/30/00	30	<1	11.1	17.0	<3	4.1	106				20	1000	
MBR-002	03/07/01		<1	11.8	18.2	<3	4.5	116				20	1000	
MBR-002	05/22/01		<1	5.3	7.6	**<3**	1.4	36				50	1000	
MBR-002	08/29/01		<1	9.7	14.7	<3	3.4	87				30	1000	
MBR-002	11/14/01	89	<1	12.1	18.6	<3	4.7	120				30	1000	
MBR-002	03/26/02		<1	10.6	16.1	<3	3.8	99				30	1000	
MBR-002	06/04/02		2	3.0	3.9	**<3**	0.6	15				830	1000	
MBR-002	08/27/02	123	<1	9.6	14.5	<3	3.3	86				30	1000	
MBR-002	11/05/02	75	<1	10.7	16.4	<3	3.9	101				20	1000	
MBR-002	03/19/03	67	1	11.8	18.1	<3	4.5	115				40	1000	
MBR-002	06/03/03		2	2.9	3.8	**<3**	0.5	14				**1160**	1000	
MBR-002	09/10/03	89	<1	7.9	11.6	**<3**	2.5	63				20	1000	
MBR-001	08/25/00		1	9.0	13.5	<3	3.0	78				30	1000	
MBR-001	10/30/00	31	<1	8.3	12.3	**<3**	2.7	68				20	1000	
MBR-001	03/07/01		<1	9.2	13.9	<3	3.1	81				20	1000	
MBR-001	05/22/01		<1	3.7	5.1	**<3**	0.8	21				80	1000	
MBR-001	08/29/01		<1	9.2	13.9	<3	3.1	81				30	1000	
MBR-001	11/14/01	78	<1	8.8	13.1	**<3**	2.9	74				30	1000	
MBR-001	03/26/02		<1	8.9	13.3	<3	3.0	76				30	1000	
MBR-001	06/04/02		2	2.9	3.8	**<3**	0.5	14				880	1000	
MBR-001	08/27/02	132	<1	9.6	14.5	<3	3.3	86				30	1000	
MBR-001	11/05/02	72	<1	8.6	12.8	**<3**	2.8	72				30	1000	

Table 4-22. Water quality metals data, Boulder River segment MT43B004_132

Station ID	Date	Flow (cfs)	Copper (µg/L)			Lead (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
MBR-001	03/19/03	58	1	9.0	13.5	<3	3.0	78				50	1000	
MBR-001	06/03/03		1	2.9	3.8	**<3**	0.5	14				**1090**	1000	
MBR-001	09/10/03	86	<1	7.8	11.5	**<3**	2.4	62				20	1000	
11	08/13/99		<1	4.0	5.5	**<2**	0.9	23	**<3**	N/A	0.7	60	1000	
UYBR004	05/25/04		1.0	3.5	4.8	**<1**	0.8	19	**<1**	N/A	0.6	70	1000	
UYBR004	06/04/04		1.0	3.2	4.4	**<1**	0.7	17	**<1**	N/A	0.5	170	1000	
SWTMB-1A	08/15/03	133	<1	4.2	5.9	<1	1.0	25	**<1**	N/A	0.8	40	1000	
SWTMB-1A	10/01/03	73	<1	5.1	7.1	<1	1.3	33	<1	N/A	1.2	100	1000	

Table 4-22. Water quality metals data, Boulder River segment MT43B004_132 (continued)

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Nickel (µg/L)			Zinc (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
13	08/13/99		<0.1	0.27	2.11	3	63	1,315	<10	38	339	<10	86	86
SWTMB-38A	10/01/03	70	<0.1	0.31	2.56	<1	100	2,086	<10	61	545	<10	139	139
UYBR002	05/25/04		<0.1	0.19	1.31	<1	58	1,221	<10	35	314	<1	80	80
UYBR002	06/04/04		<0.1	0.14	0.88	1	42	884	<10	25	225	<1	57	57
SWTMB-19A	08/15/03	130	<0.1	0.26	2.03	<1	83	1,735	<10	50	451	<10	115	115
SWTMB-19A	10/01/03	73	<0.1	0.31	2.59	<1	101	2,109	<10	61	552	<10	141	141
SWTMB-19A	09/03/04		<0.1	0.27	2.18	<1	88	1,833	<10	53	477	<1	122	122
12	08/13/99		<0.1	0.16	1.03	3	48	1,004	<10	28	256	<10	65	65
UYBR003	05/25/04		<0.1	0.16	1.01	<1	47	985	<10	28	251	<1	64	64
UYBR003	06/04/04		<0.1	0.13	0.81	2	39	823	<10	23	209	<1	53	53
MBR-002	08/28/00		<0.1	0.27	2.13	<1	86	1,803	<20	52	469	<10	120	120
MBR-002	10/30/00	30	<0.1	0.32	2.63	<1	102	2,136	<20	62	559	<10	143	143
MBR-002	03/07/01		<0.1	0.33	2.83	<1	108	2,263	<20	66	593	<10	152	152
MBR-002	05/22/01		<0.1	0.17	1.10	<1	50	1,055	<20	30	270	<10	69	69
MBR-002	08/29/01		<0.1	0.28	2.24	<1	90	1,877	<20	54	489	<10	125	125
MBR-002	11/14/01	89	<0.1	0.34	2.89	<1	110	2,305	<20	67	605	<10	155	155
MBR-002	03/26/02		<0.1	0.30	2.48	<1	97	2,036	<20	59	532	<10	136	136
MBR-002	06/04/02		<0.1	0.10	0.54	4	29	598	**<20**	17	150	<10	38	38
MBR-002	08/27/02	123	<0.1	0.28	2.22	<1	89	1,862	<20	54	485	<10	124	124
MBR-002	11/05/02	75	<0.1	0.31	2.52	<1	99	2,065	<20	60	540	<10	138	138
MBR-002	03/19/03	67	<0.1	0.33	2.81	<1	108	2,249	<20	66	590	<10	151	151

Table 4-22. Water quality metals data, Boulder River segment MT43B004_132 (continued)

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Nickel (µg/L)			Zinc (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
MBR-002	06/03/03		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-002	09/10/03	89	<0.1	0.23	1.74	<1	73	1,533	<20	44	397	<10	101	101
MBR-001	08/25/00		<0.1	0.26	2.05	<1	83	1,744	<20	50	453	<10	116	116
MBR-001	10/30/00	31	<0.1	0.24	1.85	<1	77	1,609	<20	46	417	<10	106	106
MBR-001	03/07/01		<0.1	0.27	2.11	<1	85	1,788	<20	52	465	<10	119	119
MBR-001	05/22/01		<0.1	0.12	0.71	<1	36	745	<20	21	188	<10	48	48
MBR-001	08/29/01		<0.1	0.27	2.11	<1	85	1,788	<20	52	465	<10	119	119
MBR-001	11/14/01	78	<0.1	0.26	1.98	<1	81	1,699	<20	49	441	<10	113	113
MBR-001	03/26/02		<0.1	0.26	2.02	<1	83	1,729	<20	50	449	<10	115	115
MBR-001	06/04/02		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-001	08/27/02	132	<0.1	0.28	2.22	3	89	1,862	<20	54	485	<10	124	124
MBR-001	11/05/02	72	<0.1	0.25	1.94	<1	80	1,669	<20	48	433	<10	111	111
MBR-001	03/19/03	58	<0.1	0.26	2.05	<1	83	1,744	<20	50	453	<10	116	116
MBR-001	06/03/03		<0.1	0.10	0.52	4	28	579	**<20**	16	145	<10	37	37
MBR-001	09/10/03	86	<0.1	0.23	1.72	<1	73	1,517	<20	44	393	<10	100	100
11	08/13/99		<0.1	0.13	0.78	2	38	804	<10	23	204	20	52	52
UYBR004	05/25/04		<0.1	0.12	0.67	<1	34	713	<10	20	180	<1	46	46
UYBR004	06/04/04		<0.1	0.11	0.61	<1	31	656	<10	18	165	<1	42	42
SWTMB-1A	08/15/03	133	<0.1	0.14	0.84	<1	41	848	<10	24	215	<10	55	55
SWTMB-1A	10/01/03	73	<0.1	0.16	1.03	<1	48	1,004	<10	28	256	<10	65	65

4.5.3.3 Boulder River Segment MT43B004_133

The 2006 303(d) list does not identify Boulder River Segment MT43B004_133 as impaired due to metals. This segment is included here because additional data, unavailable during the most recent assessment, show water quality target exceedances.

Water Quality Data Results

Water quality metals samples from segment MT43B004_133 have been collected primarily by the USGS and DEQ, and are given in table 4-24 For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality standard for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Underlined values are the associated water quality target, adjusted for hardness where necessary. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

The only exceedance of water quality targets occurred for **lead** on 5/24/04 at site UYBR007, when lead concentration was elevated (1.0 ug/L) above the chronic level of 0.6 ug/L. The remainder of the lead data set (n=8) could not be evaluated, as reporting limits were higher than the chronic water quality standard (target).

Sediment Quality Data Results

Sediment quality data is limited to two sampling sites in 1999; data did reveal that some sediment metals concentrations were elevated above TELs (Table 4-23). Sediment concentrations of both chromium and nickel were slightly elevated above TELs at sampling site UYBR005, but were below TELs at site UYBR006.

Table 4-23. Sediment water quality metals data, Boulder River segment MT43B004_133

		Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR005	8/13/1999	ND	0.596	3.53	**40**	37.3	90	10	35.7	197
UYBR006	8/13/1999	ND	0.596	3.53	28	37.3	90	7	35.7	197
		Lead (ppm)			**Nickel (ppm)**			**Silver (ppm)**		
		Value	**TEL**	**PEL**	**Value**	**TEL**	**PEL**	**Value**	**TEL**	**PEL**
UYBR005	8/13/1999	5	35	91	**22**	18	35.9	ND	0.733	1.77
UYBR006	8/13/1999	ND	35	91	17	18	35.9	ND	0.733	1.77

Data Discussion

Only one lead sample demonstrated a target exceedance; however reporting limits were too high to adequately evaluate compliance with the water quality target during all other sample events. It is possible that additional exceedances of the water quality target for lead occurred, yet analytical procedures preclude their evaluation. Since lead exceedances also occur lower in the Boulder River (segment MT43B004_131), and abandoned mine sources exist in the upper watershed, it is reasonable to assume that any lead exceedances observed on contiguous segments of the Boulder River are related to similar sources, and can be reduced through similar control efforts.

Chromium and nickel sediment concentrations are elevated above the TEL at UYBR005, however no water quality target exceedances of these metals were observed.

Conclusion

It is concluded that exceedance of the lead water quality target demonstrates that **Boulder River Segment MT43B004_133 is impaired from elevated lead levels. A lead TMDL will be developed for Boulder River segment MT43B004_133.**

Table 4-24. Water quality metals data, Boulder River segment MT43B004_133

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Copper (µg/L)			Lead (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
10	08/13/99		<0.1	0.12	0.68	1	34	715	<1	3.6	4.8	**<2**	0.8	19
UYBR005	06/04/04		<0.1	0.11	0.64	<1	33	687	1.0	3.4	4.6	**<1**	0.7	18
UYBR005	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14
SWTMB-3	10/01/03	70	<0.1	0.13	0.78	<1	38	804	<1	4.0	5.5	**<1**	0.9	23
UYBR006	06/04/04		<0.1	0.10	0.58	<1	30	630	2.0	3.1	4.2	**<1**	0.6	16
UYBR006	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14
6	08/13/99		<0.1	0.10	0.54	2	28	593	<1	2.9	3.9	**<2**	0.6	14
UYBR007	06/04/04		<0.1	0.10	0.57	<1	30	624	1.0	3.1	4.1	**1**	0.6	16
UYBR007	05/25/04		<0.1	0.10	0.52	<1	28	579	1.0	2.9	3.8	**<1**	0.5	14

Table 4-24. Water quality metals data, Boulder River segment MT43B004_133 (continued)

Station ID	Date	Flow (cfs)	Nickel (µg/L)			Zinc (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
10	08/13/99		<10	20	180	<10	46	46	**<3**	N/A	0.6	80	1000	
UYBR005	06/04/04		<10	19	173	<1	44	44	**<1**	N/A	0.5	40	1000	
UYBR005	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	130	1000	
SWTMB-3	10/01/03	70	<10	23	204	<10	52	52	**<1**	N/A	0.7	<10	1000	
UYBR006	06/04/04		<10	18	158	<1	40	40	**<1**	N/A	0.4	40	1000	
UYBR006	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	120	1000	
6	08/13/99		<10	17	149	<10	38	38	**<3**	N/A	0.4	40	1000	
UYBR007	06/04/04		<10	17	157	<1	40	40	**<1**	N/A	0.4	40	1000	
UYBR007	05/25/04		<10	16	145	<1	37	37	**<1**	N/A	0.4	610	1000	

4.5.3.4 Boulder River Segment MT43B004_134, and Basin Creek Segment MT43B005_010

The 2006 303(d) list identifies Boulder River Segment MT43B004_134 as impaired due to metals: copper, lead. Basin Creek was not assessed and was not incorporated into the 2006 303(d) list, but is included here since one or more metals targets were exceeded.

Water Quality Data Results
Water quality metals samples from segment MT43B004_134 have been collected primarily by the USGS and DEQ, and are given in table 4-26. For each listed pollutant, the water quality sampling result is in the '*Value*' column and the chronic and acute water quality standard for the sampling event is given in columns, '*Chronic*' and '*Acute*'. Underlined values are the associated water quality target, with hardness adjustments where appropriate. Values in **bold** were unable to be evaluated because reporting limits were higher than the water quality target. Values in **grey-box bold** are exceedances of the water quality target.

There were no water quality exceedances of metals in the data set which included three water quality samples taken downstream of Basin Creek. Samples taken from Basin Creek by the DEQ's Abandoned Mine Program showed water quality target exceedances of both copper and lead on two separate occasions in 1993.

Sediment Quality Data Results
Sediment quality data is limited, however data did reveal some sediment metals concentrations elevated above TELs (Table 4-25). Sediment concentrations of both copper and nickel were slightly elevated above TELs at sampling site UYBR008.

Table 4-25. Sediment water quality metals data, Boulder River segment MT43B004_134

		Cadmium (ppm)			Chromium (ppm)			Copper (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR008	8/13/1999	ND	0.596	3.53	20	37.3	90	65	35.7	197
		Lead (ppm)			Nickel (ppm)			Silver (ppm)		
		Value	TEL	PEL	Value	TEL	PEL	Value	TEL	PEL
UYBR008	8/13/1999	9	35	91	26	18	35.9	ND	0.733	1.77

Data Discussion
Water quality data, while limited, show no water quality target exceedances for segment MT43B004_134. Sediment quality data show copper and nickel concentrations above the TEL.

The Independence Mining District lies at the headwaters of Basin Creek, a tributary to the Boulder River, and is on the State's Priority Abandoned Mines List. Abandoned mines are scattered throughout this area and are likely contributors to metals contamination in Basin Creek and downstream in the Boulder River. Water quality and sediment quality data collected in Basin Creek by the DEQ's Abandoned Mines Program in August 1993 showed exceedances of copper and lead water quality targets, and sediment levels of copper and lead in Basin Creek were among the highest in the watershed. Onsite adit discharges were also sampled: maximum copper concentration was 186 ug/L.

The dearth of data for Boulder River segment MT43B004_134 limits interpretation. Known sources of metals contamination exist in Basin Creek, and Basin Creek itself shows elevated levels of metals in both the sediment and water quality samples. Additional water quality data under a variety of flow conditions is recommended in order to better characterize water quality conditions.

Conclusion
While water quality conditions in Boulder River Segment MT43B004_134 do not exceed water quality standards, the paucity of data available precludes determination of water quality condition with a high level of certainty.

Because significant metals sources exist in Basin Creek, and there are exceedances of water quality targets, **copper and lead TMDLs will be developed for Basin Creek segment MT43B005_010.**

Table 4-26. Water quality metals data, Boulder River segment MT43B004_134

Station ID	Date	Flow (cfs)	Cadmium (µg/L)			Chromium (µg/L)			Copper (µg/L)			Lead (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
UYBR008	05/25/04		<0.1	0.15	0.96	<1	45	946	1.0	4.8	6.7	<1	1.2	30
UYBR008	06/04/04		<0.1	0.14	0.83	1	40	839	2.0	4.2	5.8	<1	1.0	25
1.0	08/13/99		<0.1	0.10	0.52	3	28	579	1.0	2.9	3.8	**<2**	0.5	14

Table 4-26. Water quality metals data, Boulder River segment MT43B004_134 (continued)

Station ID	Date	Flow (cfs)	Nickel (µg/L)			Zinc (µg/L)			Silver (µg/L)			Iron (µg/L)		
			Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute	Value	Chronic	Acute
UYBR008	05/25/04		<10	27	241	<1	61	61	<1	N/A	1.0	50	1000	
UYBR008	06/04/04		<10	24	213	<1	54	54	**<1**	N/A	0.8	600	1000	
1.0	08/13/99		**<10**	16	145	20	37	37	**<3**	N/A	0.4	70	1000	

4.5.4 Boulder River Metals Assessment Summary

Present understanding of the conditions under which Boulder River water quality exceeds water quality standards for metals is limited by the spatial and temporal constraints of the existing data. Most elevated metals concentrations occur during spring runoff flows, when low hardness values make the Boulder River susceptible to chronic metals exceedances. Along its length the Boulder River has exhibited exceedances of water quality criteria for copper, lead and iron, particularly during seasonal high flow periods. While each segment does not necessarily exhibit water quality criteria exceedances for each metal of concern, sources of metals are thought to be common to all segments and are predominantly from natural and historical mining sources (abandoned mines) throughout the watershed. Controlling and remediating loading from these sources will not only act to reduce loading of copper, lead and iron on all segments of the Boulder River, but also reduce elevated levels of other metals that may be impacting beneficial uses but where limited data precludes evaluation.

As such, TMDLs for copper, lead and iron will be prepared for Boulder River segments MT43B004_131, MT43B004_132, MT43B004_133, MT43B004_134 and Basin Creek segment MT43B005_010, and are given in Section 5.0. Table 4-27 provides a summary of verified target exceedances in the Boulder River, and subsequent TMDL preparation. Additional data collection and source assessments is recommended and will allow a more accurate characterization of water quality conditions under higher flow conditions, and assist in further evaluating compliance with water quality targets.

Table 4-27. Boulder river metals impairment summary

<table>
<tr><th>Water Body Segment</th><th>2006 303(d) Listing (metals)</th><th>Verified Target Exceedances (metals)</th><th>TMDLs Prepared (Section 5)</th></tr>
<tr><td>MT43B004_131</td><td>Copper
Lead
Silver
Iron</td><td>Copper
Lead</td><td rowspan="5">Copper
Lead
Iron</td></tr>
<tr><td>MT43B004_132</td><td>Nickel
Chromium</td><td>Iron</td></tr>
<tr><td>MT43B004_133</td><td>None</td><td>Lead</td></tr>
<tr><td>MT43B004_134</td><td>Copper
Lead</td><td>Copper
Lead</td></tr>
<tr><td>MT43B005_010</td><td>None</td><td>Copper
Lead</td></tr>
</table>

4.5.5 Recommendations

4.5.5.1 Water Quality Monitoring

In order to adequately characterize conditions that contribute to water quality impairment in the Boulder River, annual synoptic water quality sampling for metals is recommended. While data shows that chronic water quality standards for some metals are exceeded at times during seasonal runoff, further synoptic sampling events during the rising limb, falling limb and at base flow

(Figure 4-17) of the typical Boulder River hydrograph will assist in meeting a variety of monitoring goals:

1. Obtain a better understanding of processes that lead to chronic metals impairments in the Boulder River
2. Estimate metals loading to the Boulder River from different source areas
3. Refine further metals source assessments
4. Prioritize remediation and restoration activities.

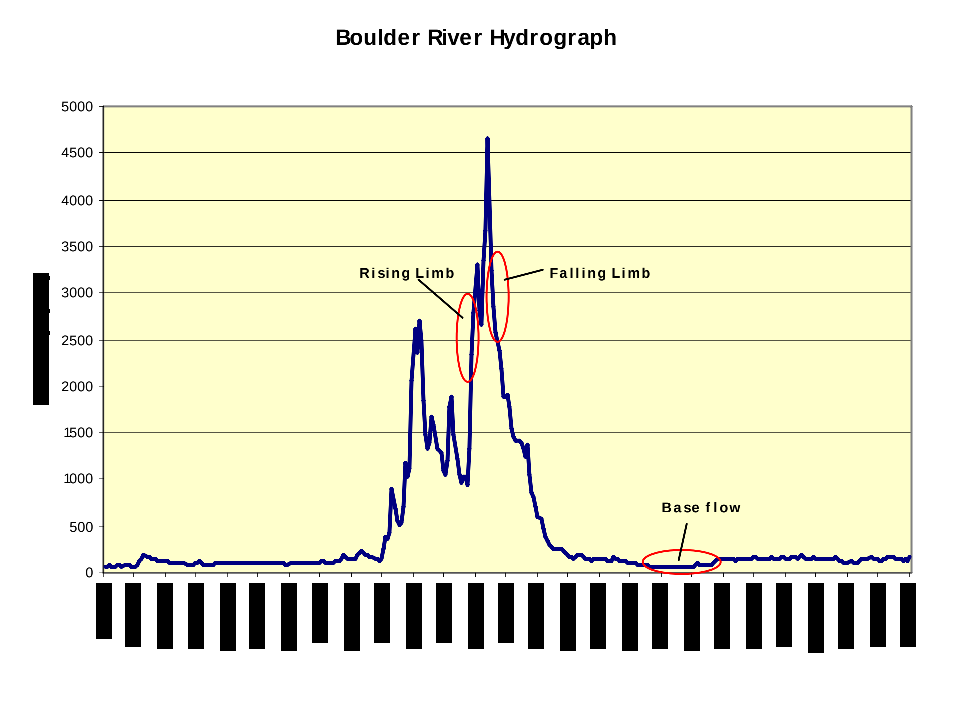

Figure 4-17. Boulder river hydrograph

Sampling sites for each synoptic sampling event should be chosen to include:

- Mouths of major tributaries (West Boulder River, East Boulder River)
- Mouths of selected tributaries known to have mining-related metals sources (including Basin Creek)
- Mouths of selected unmined tributaries.
- Multiple mainstem Boulder River sites within each segment

Water quality samples collected at each site should include, at a minimum, the following field parameters and lab analysis:

- Field Parameters (instantaneous discharge, pH, water temperature, electroconductivity)
- Water Quality Analysis – (dissolved metals, total recoverable metals, hardness, suspended solids, sediment metals)

Provided above is a basic framework for continued monitoring and investigation of metals issues in the Boulder river watershed. Final sampling design, standard operating procedures, analytical methods, and quality assurance measures should be detailed in a formal Sampling and Analysis Plan (SAP) that has been approved by the DEQ.

SECTION 5.0
BOULDER RIVER METALS TMDLS AND ALLOCATIONS

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, MDEQ must identify water bodies not meeting water quality standards and then establish TMDLs for those pollutants responsible for water quality impairment. In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollutant that must be reduced to meet water quality standards, allocates pollution control or management among sources in a watershed, and provides a framework for taking actions needed to restore a water body.

As concluded in Section 4.0, TMDLs for copper, lead and iron are calculated for Boulder River segments MT43B004_131, MT43B004_132, MT43B004_133 and MT43B004_134, and for Basin Creek, MT43B005_010.

Metals (copper, lead, iron) TMDLs in the Boulder River watershed will address the following elements:

- **Loading Capacity (LC)** or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- **Waste Load Allocation (WLA)** or the portion of the TMDL allocated to existing and future point sources
- **Load Allocation (LA)** or the portion of the TMDL allocated to existing and future nonpoint sources and natural background
- **Margin of Safety (MOS)** or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

These elements are combined in equation 1:

$$\boldsymbol{TMDL} = \text{LC} = \boldsymbol{\Sigma}\text{WLA} + \boldsymbol{\Sigma}\text{LA} + \text{MOS}$$

In addition, the TMDL must also take into account the seasonal variability of pollutant loads and adaptive management strategies in order to address uncertainties inherent in environmental analyses. The above described elements will be detailed throughout the remainder of this section.

5.1 Source Characterization and Assessment

This section identifies sources of copper, lead and iron in the Boulder River watershed. Potential source categories include those from natural sources (non-anthropogenic sources), point sources (MPDES permitted sources), and non-point sources (non-permitted sources generally introduced to the system via runoff). Sources identified within each category are presented below.

5.1.1 Natural Sources

Natural sources of metals are those that contribute metals independently of human disturbance or influence. Natural sources are geologically derived from metals found within the Earth's crust. The geology throughout the watershed is mineral rich and has the potential to contribute metals to receiving waters through natural weathering and transport processes.

Assessing the level of natural background metals in the Boulder River watershed is problematic due to a variety of reasons:

- Abandoned mines and their associated waste are scattered throughout the watershed
- Detection limits for many water quality data are not low enough to provide detection results at low concentrations

Because of the uncertainty inherent in knowing natural background levels, water quality standards exceedance evaluations and subsequent water quality impairment determinations are based on certain assumptions:

- natural background metals concentrations remain below the chronic water quality criteria for aquatic life under all flow conditions
- single water quality samples represent a 96-hour average water quality concentration

5.1.2 Point Sources

Two permitted point sources exist in the Boulder River watershed:

- East Boulder Mine (MPDES permit MT-0026808) located in the Upper East Boulder River watershed.
- City of Big Timber domestic wastewater treatment lagoon (MPDES permit MT-0020753) located on the Lower Boulder River near the confluence with the Yellowstone River

The East Boulder Mine MPDES permit allows discharges from the site through groundwater and surface water outfalls. To date, no direct discharges to the East Boulder River through surface water outfall have occurred: all discharges have been disposed of via infiltration to ground water through two percolation ponds. In-stream water quality monitoring data above and below the percolation ponds show *no detectable increase in metals loading* from the East Boulder Mine (unpublished monitoring reports).

The City of Big Timber MPDES permit allows direct discharges from its domestic wastewater treatment lagoon to the Boulder River. Permit MT-0020753 does not specifically provide load limits for metals, or require ambient monitoring for these water quality parameters. Consequently, existing metals loading from this point source is unknown, but are expected to be low.

As required for all permitted point sources, a metals (Cu, Pb, Fe) wasteload allocation (WLA) will be provided for these point sources and are given in Section 5.3.2.

5.1.3 Non-point Sources

Non-point pollution originates from diffuse sources throughout the watershed. This type of pollution is caused by rainfall or snowmelt moving over and through the landscape. As the runoff moves, it picks up and carries away pollutants and deposits them into area receiving waters. The majority of non-point source metals loading occurring in the Boulder River watershed is thought to originate from those sources associated with historic mining practices and abandoned mines in the watershed.

5.1.3.1 Historic Mining and Abandoned Mines

Section 4.0 discusses abandoned mining in the watershed and contamination sources associated with abandoned mining. These sources include adit discharges, waste rock piles and tailings, and in-stream or bank deposits. There are a number of known abandoned mines within the basin. Although the total number of mines is fairly large, Priority Abandoned Mine Sites in the basin are limited to the Independence Mining District in the headwaters of the Boulder River.

Mining districts within the Boulder River basin include the following and are discussed in more detail below:

- Boulder River (gold, silver, copper, lead and chromium)
- Natural Bridge (gold, silver, and copper)
- Independence (gold, silver, copper and lead)

Boulder River District
The Boulder River Mining District was located in the Contact Mountain area and at the head of the East Boulder River about 30 miles south of Big Timber. Most of the mines in the district exploited the lower Stillwater Complex, which was relatively rich in copper and nickel sulfides, and chromite (chromium oxide). The most important mines in the area were the East Boulder, the Gish, Hubble Gulch, the Minnie, and Wright Gulch. None of the mines in the district are on the Priority Abandoned Mines List, and only one, the Gish, was reported to have an adit flow. No data were available from the Gish adit.

Natural Bridge District
The Natural Bridge District was located in the area of Placer Basin, which is a tributary of the East Boulder River. The district was to exploit the copper, gold and silver associated with the basal Stillwater Complex; however, mine production consisted only of test shipments.

Independence District
The Independence Mining District was located about 60 miles south of Big Timber near the head of the main stem of the Boulder River, including the area around Independence Peak and extending to Carbonate Mountain to the northwest. Gold, silver, copper, and lead were produced in the district from the free-milling oxidized zones of fissure veins within granite and diorite. The most important mines in the district were the Hidden Treasure, the Yager/Daisy, the Poorman, and the Independence, all of which had their own stamp mills and concentrators. The tailings produced from the mills contained mostly pyrite and trace chalcopyrite. Each of the principal mines had one or more shafts or adits, some of which have discharges to Basin Creek (a tributary

to Boulder River). In 1993, the Montana Department of State Lands (now DEQ) conducted an evaluation of the Yager/Daisy, the Poorman, and the Independence properties and inventoried the volume of unimpounded tailings/waste rock, and identified and sampled discharging adits at each site. The sampling results for the adit discharges from the Yager and Poorman sites are presented in Table 5-1**.**

Table 5-1. Adit discharge data from Yager and Poorman Sites (MDEQ 1993)

Property	Sample Location	Copper (ug/L)	Lead (ug/L)
Poorman	GW-1	3.2	1.07
Poorman	GW-2	1.9	0.72
Yager	GW-1	5.37	1.33
Yager	GW-2	8.13	0.72
Yager	GW-3	**186**	1.22
Yager	GW-4	3.07	**9.37**

In addition to the ground water samples, two surface water samples were taken at the Yager location. Table 5-2 contains these data as well as an estimated load being introduced to the system from this location. Load was estimated using the sampled concentrations and the documented flow along with a conversion factor to result in pounds per day load.

Table 5-2. Surface water samples and estimated load from Yager site (MDEQ 1993)

		Concentration		Load	
Sample Location	Flow	Copper (ug/L)	Lead (ug/L)	Copper (lbs/day)	Lead (lbs/day)
SW-1	2.01	4.53	1.05	0.05	0.01
SW-2	0.825	2.27	0.75	0.01	0.003

All samples (ground and surface water) were collected in August and are considered to be low flow data. It is presumed that loading of copper and lead to Basin Creek would also be greater under higher flow conditions as lower quality waters are often flushed from mine workings during runoff.

5.1.3.2 Other Non-Point Sources

Another source of metals associated with abandoned mining is contaminated sediment. Historic practices likely distributed metals throughout the stream channels downstream of mining sites. Over time, metals settled into the substrate and streambanks and are reintroduced to the system during high flow events when sediments are stirred and streambanks are eroded. Sediment data are limited and were discussed in Section 4.4.2. The extent of loading from contaminated sediments is unknown, however, future monitoring (discussed in Section 4.5.5.1) may help gage the significance of this source and erosion reduction measures can help limit any load contribution from sediments.

5.1.4 Source Assessment Summary

Anthropogenic sources of metals in the Boulder Watershed are derived mainly from historic mining practices and abandoned mines scattered throughout the watershed. Metals are introduced to the stream primarily through land runoff during runoff and adit discharges. The Boulder River is particularly susceptible to water quality standards exceedences during high flows when 1) metals from land runoff are entering the stream and 2) low hardness values result in a lower water quality standard. Permitted discharges do not contribute significant metals loads to the Boulder River.

5.2 TMDLs and Load Allocations

TMDLs and load allocations will be presented below for 4 discrete segments of the Boulder River, MTB004_131, MTB004_132, MTB004_133 and MTB004_134, and for Basin Creek segment MTB005_010 (Table 5-3). Segments MTB004_131 and MTB004_132 have permitted discharges within their contributing watershed area, and so wasteload allocations (in addition to load allocations) will be presented for these segments. Boulder River segments MTB004_133 and MTB004_134 and Basin Creek do not require a waste load allocation and will be treated separately from segments MTB004_131 and MTB004_132.

Table 5-3. Boulder River TMDLs

Water Body Segment	TMDLs
Boulder River MTB004_131	copper, lead, iron
Boulder River MTB004_132	copper, lead, iron
Boulder River MTB004_133	copper, lead, iron
Boulder River MTB004_134	copper, lead, iron
Basin Creek MTB005_010	copper, lead, iron

A water body’s allowable loading capacity, or total maximum load, for most metals is dependent upon two factors: the water quality target and the streamflow. As described in Section 4.0, the water quality target is the chronic aquatic life use standard. As the copper and lead standard is dependent on ambient water hardness, allowable copper and lead loads for any given flow will vary with water hardness (figure 5-1).

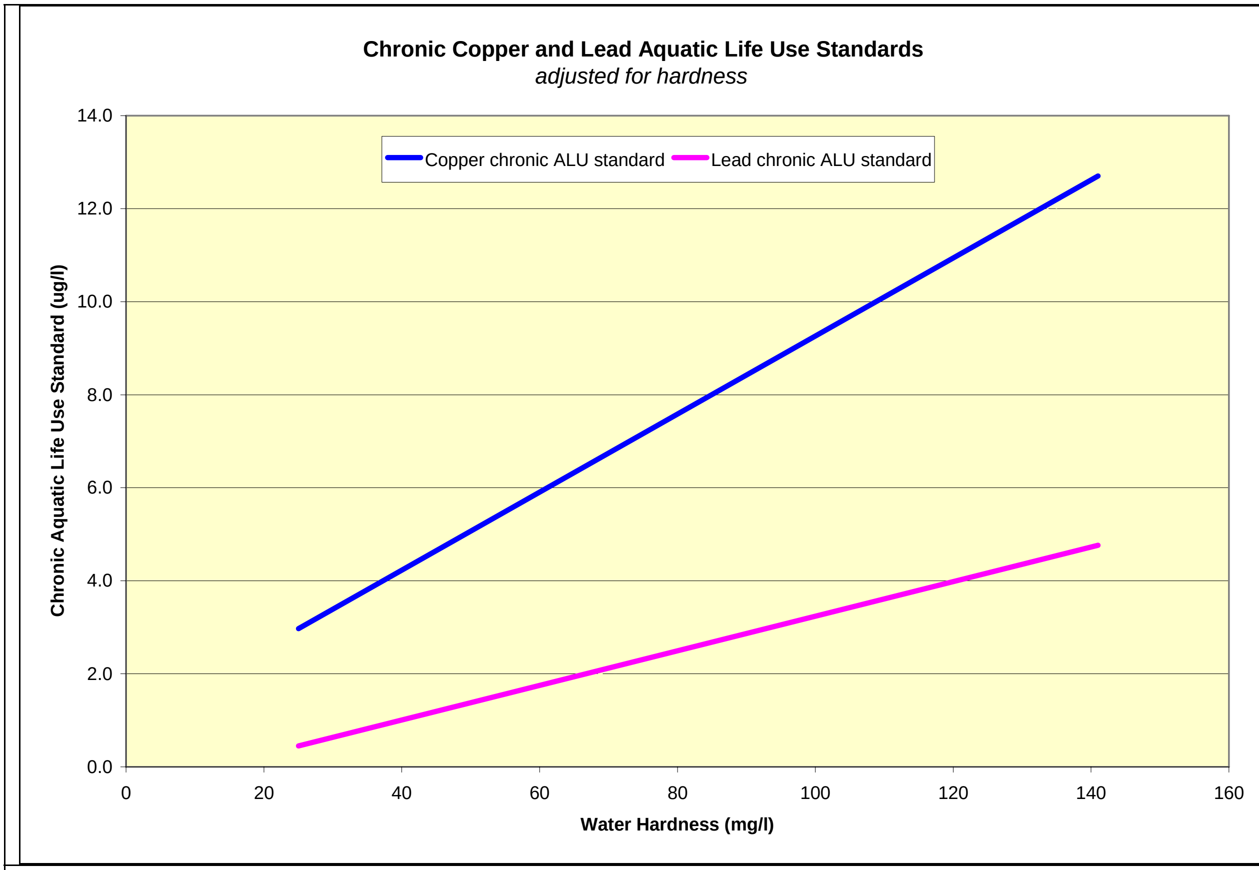

Figure 5-1. Chronic aquatic life standards for copper and lead

Given known hardness and streamflow, Total Maximum Daily Loads for copper, lead and iron are calculated using equation 2 (below). Once TMDLs have been calculated, the loading capacity is allocated among the different sources: natural sources & nonpoint sources (load allocation), and permitted discharges (waste load allocation). A margin of safety is also incorporated into the allocations.

5.2.1 Total Maximum Daily Loads

Copper, lead and iron TMDLs are presented herein for Boulder River Segments MTB004_131, MTB004_132, MTB004_133, MTB004_134 and Basin Creek, MTB005_010. Target exceedences are primarily witnessed in the lower Boulder River (MTB004_131, MTB004_132), however the main sources of metals occur in the upper watershed. Exceedences of metals water quality targets were observed in the upper Boulder River and in Basin Creek; however limited data precludes the confident estimation of *existing loads* for these segments. Because of the existence of known sources in the watershed, TMDLs are provided for all Boulder River segments.

As copper and lead TMDLs are dependent upon flow and hardness, a static Total Maximum Daily Load is not given. The iron TMDL is not dependent upon hardness, so no hardness adjustments are made to the iron water quality target. Equation 2 is used to calculate the TMDL under any given harness and flow conditions.

Equation 2

TMDL = (X) (Y) (0.0054)

TMDL=	*Total Maximum Daily Load in lbs/day*
X=	*the chronic aquatic life use standard (target) with hardness adjustments where applicable in ug/l*
Y=	*streamflow in cubic feet per second*
(0.0054) =	*conversion factor*

During seasonal high flows in May and June, hardness values drop below 40 mg/l in the lower Boulder River resulting in a lower water quality targets for copper and lead. Low hardness values, and associated lower aquatic life standards, however are not limited solely to runoff conditions (Figure 5-2). Low hardness values are witnessed periodically during all seasons (Figure 5-3).

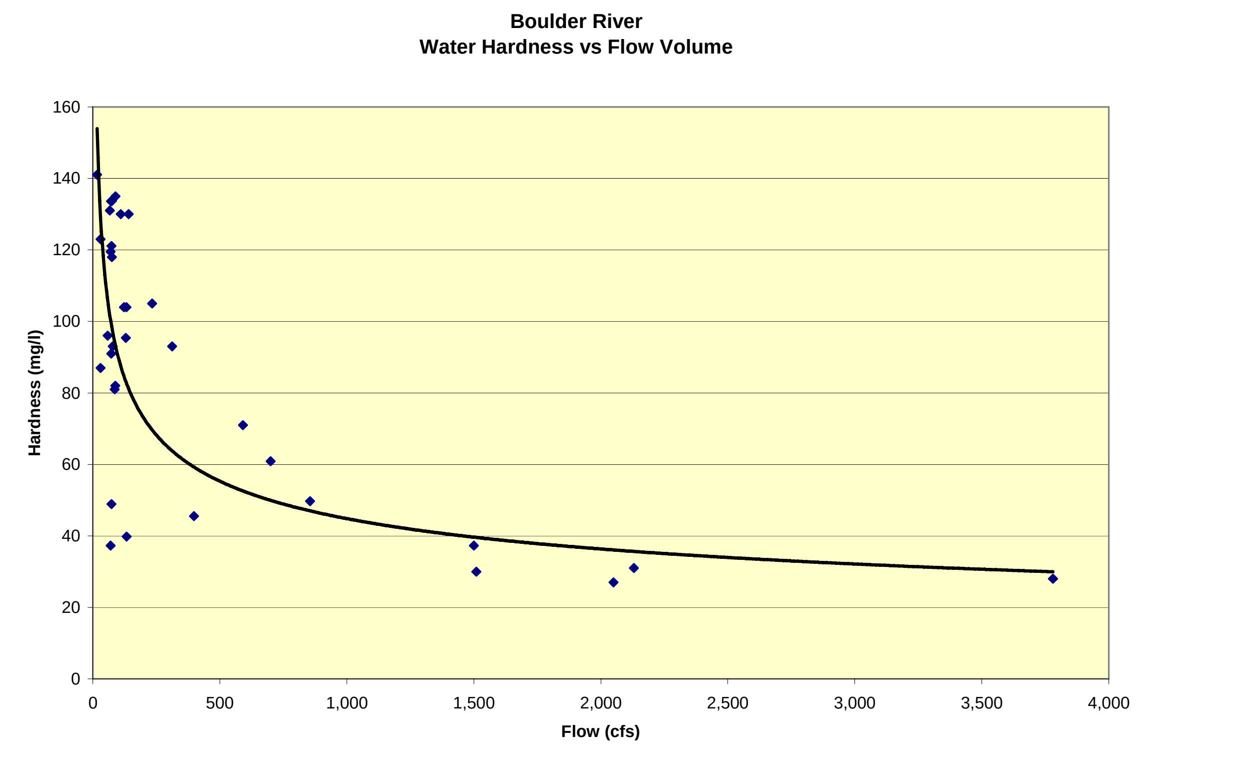

Figure 5-2. Lower Boulder River: hardness vs flow

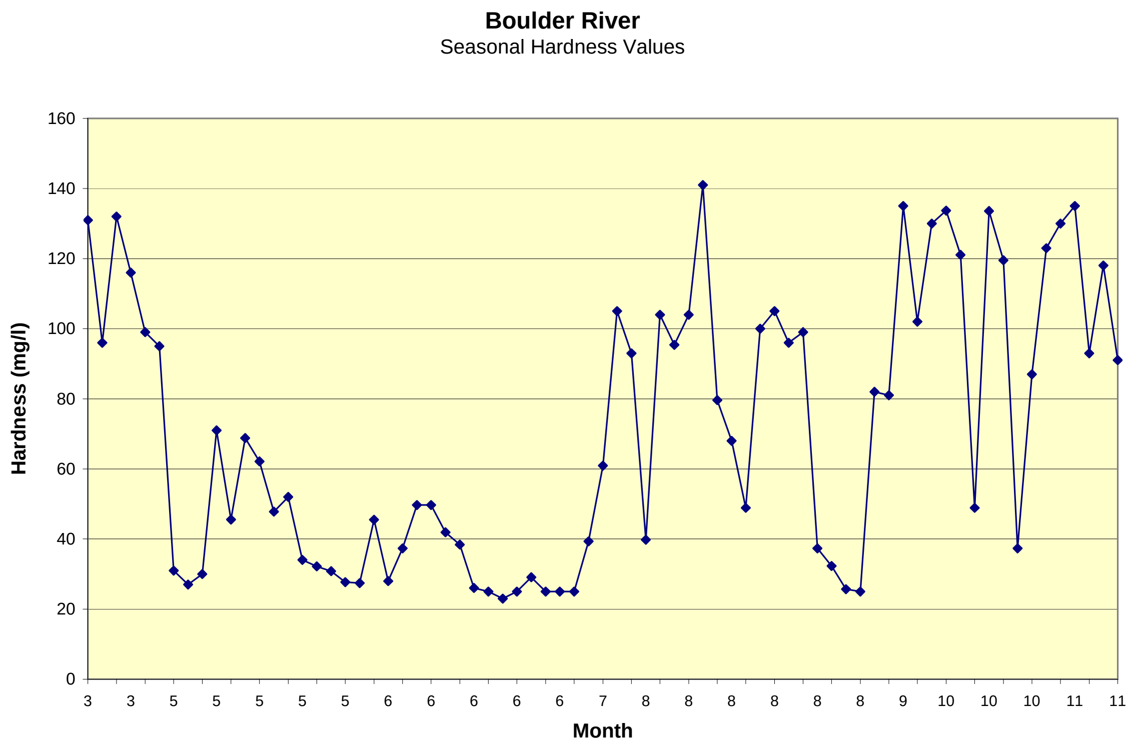

Figure 5-3. Lower Boulder River: seasonal hardness values

Data shows (Section 4.0) that copper and lead concentrations in the lower Boulder River are elevated above water quality targets under most high flow conditions (flows > 1500 cfs) during May and June. While not affected by hardness values, in-stream iron concentrations have also exceeded the water quality target during high flow conditions. Necessary load reductions therefore apply particularly to high flow conditions, and strategies to reduce pollutant loading should address those processes and mechanisms that influence elevated metals concentrations during seasonal runoff.

To illustrate the magnitude of load reductions necessary to meet water quality standards under water quality exceedence conditions in the lower Boulder River, TMDLs and estimated load reductions are calculated for high flow conditions (Table 5-4). Table 5-4 also shows the metals loading capacity when water hardness=25mg/l (the lowest possible target value) and flow=1500 cfs. Necessary reduction to meet water quality targets are given in the far column. This condition represents water quality conditions experienced in the lower Boulder River periodically during seasonal runoff or other times of year when water hardness levels are their lowest.

Table 5-4. High flow TMDL (1500 cfs)

Metal	Target ug/l	TMDL lbs/day	Existing Load* lbs/day	Assimilative Capacity lbs/day	Necessary % reduction
Copper	2.9	23.4	34.3	-10.9	31%
Lead	0.5	4.0	10.7	-6.7	63%
Iron	1,000	8,090	9,100	-1010	11%
*assume average metals concentrations at flows >1500 cfs					

During low flow conditions (hardness = 100 mg/l, flow = 38 cfs) the TMDL is less, but due to higher hardness the water quality target is higher, resulting in in-stream loads under the allowable loading capacity.

Table 5-5. Low flow TMDL (38 cfs)

Metal	Target ug/l	TMDL lbs/day	Existing Load* lbs/day	Assimilative Capacity lbs/day	Necessary % reduction
Copper	9.3	1.9	0.102	1.80	0%
Lead	3.2	0.66	0.102	0.56	0%
Iron	1,000	205	6.1	199	0%
*assume average metals concentrations at flows <100cfs					

5.2.2 Allocations

A TMDL is the sum of all of the load allocations (nonpoint sources) plus all of the waste load allocations (point sources) for a water body, plus a margin of safety (MOS). Boulder River segments MTB004_131 and MTB004_132 have two permitted point sources with their contributing watershed area, requiring a wasteload allocation as part of the TMDL for these segments. Boulder River segments MTB004_133, MTB004_134 and Basin Creek, MTB005_010 do not require a wasteload allocation. Margin of safety is addressed implicitly in this TMDL through incorporation of various safety factors and contingencies incorporated into the TMDL development process. A separate explicit allocation as a margin of safety is therefore unnecessary.

Consequently, for **Boulder River segments MTB004_131 and MTB004_132** TMDLs will consist of the sum of the load allocation and the wasteload allocations: **TMDL = WLA + LA**

For Boulder River segments **MTB004_133, MTB004_134 and Basin Creek, MTB005_010** TMDLs consist solely of the nonpoint source load allocation: **TMDL = LA.**

5.2.2.1 Allocations: Segments MTB004_131 and MTB004_132

Wasteload allocations for the Boulder River **segments MTB004_131 and MTB004_132** are designed so that water quality standards at all flows and hardness values are maintained. Wasteload allocations for **cooper** and **iron** are calculated using the existing design flow of the facility and an effluent concentration at the lowest applicable acute standard (aquatic life used standard when hardness = 25 mg/l). Using an effluent concentration of the lowest acute aquatic life standard will protect from acute toxicity within the mixing zone (ARM 17.30.507(1)(b)). Because the assimilative capacity of the Boulder River for lead is much lower, the background value (1.0 ug/l) rather than acute standard for lead is used to calculate the wasteload allocations for lead. An additional WLA is provided for any additional future permitted sources, and for the future expansion of existing point source discharges. The sum of the WLAs shall not exceed 10% of the TMDL.

- **Total Load Allocation (LA) = TMDL (0.90) = 90% of the TMDL**
  The load allocation is the amount of metal in lbs/day that is allowable from present and future natural and non-natural non-point sources. Non-natural nonpoint sources are predominantly those impacts or disturbances from historical and abandoned mining practices that contribute to elevated in-stream metals concentrations. The total load allocation is expressed as a percentage (90%) of the total maximum daily load and includes the *combined* load from natural and historic mining-related sources.

  $$\mathbf{TMDL\ (0.90) = LA = LA_{(natural)} + LA_{(abmines)}}$$

- **Total Wasteload Allocation (WLA) = TMDL (0.10) = 10% of the TMDL**
  The wasteload allocation is the amount of metal in lbs/day that is allowable from present permitted point sources (MPDES MT-0026808, MPDES MT-0020753) with an allowance for potential future point sources. The total wasteload allocation (WLA) is expressed as a percentage (10%) of the total maximum daily load. Individual wasteload contributors are each allocated a portion of the total wasteload allocation, with the remaining reserved for future point source allocation.

  $$\mathbf{TMDL\ (0.10) = WLA = WLA_{(MT\text{-}0026808)} + WLA_{(MT\text{-}0020753)} + WLA_{(future)}}$$

  where:
  WLA*(MT 0026808)* = (design flow) * (acute or chronic standard at 25 mg/l hardness)
  WLA*(MT-0020753)* = (design flow) * (acute or chronic standard at 25 mg/l hardness)
  WLA*(future)* = reserved future allocation

To illustrate allocations under different conditions, Tables 5-6 and 5-7 demonstrate load and wasteload allocations for typical high and low flows for the lower Boulder River.

Table 5-6. High flow TMDL and allocations

High Flow TMDL*					
Pollutant	**TMDL**	**ΣLA**	**ΣWLA** *lbs/day*		
	lbs/day	*lbs/day*	***WLA****(MT-0026808)*	***WLA****(MT-0020753)*	***WLA****(reserved)*
Cu	23.4	21.1	0.034	0.012	2.3
Pb	4.0	3.6	0.009	0.003	0.053
Fe	8,090	7,281	8.9	3.3	797

*flow = 1500 cfs, hardness = 25 mg/l

Table 5-7. Low flow TMDL and allocations

Low Flow TMDL*					
Pollutant	**TMDL** *lbs/day*	**ΣLA** *lbs/day*	**ΣWLA** lbs/day		
			WLA*(MT-0026808)*	***WLA****(MT-0026808)*	***WLA****(reserved)*
Cu	1.91	1.72	0.034	.012	2.3
Pb	0.656	0.590	0.009	0.003	0.053
Fe	205	184	8.9	3.3	797

*flow = 38 cfs, hardness = 100 mg/l

5.2.2.2 Allocations: Segments MTB004_133 and MTB004_134

For Boulder **River segments MTB004_133 and MTB004_134, and Basin Creek segment MTB005_010** no wasteload allocation is necessary. All allowable loads of copper, lead and iron are allocated to the cumulative load from natural sources and historic and abandoned mining sources. That is, the load allocation is equal to the total maximum daily load:

- **Total Load Allocation (LA) = TMDL (1.0) = 100% of the TMDL**
  The load allocation is the amount of metal in lbs/day that is allowable from present and future natural and non-natural non-point sources. Non-natural nonpoint sources are predominantly those impacts or disturbances from historical and abandoned mining practices that contribute to elevated in-stream metals concentrations. The total load allocation is equal to the total maximum daily load and includes the combined load from natural and historic mining-related sources.

  TMDL = LA = [$LA_{(natural)}$ + $LA_{(abmines)}$]

Under most circumstances, the Boulder River does not exceed water quality targets and maintains assimilative capacity. It is under high flow conditions (expressed in table 5-4) that the TMDL is exceeded due to seasonal mobilization of anthropogenically derived nonpoint sources. It is expected that reductions in nonpoint loads through mitigation and restoration of abandoned mining sites and associated impacts will reduce the loading from controllable nonpoint metals sources to levels that fall within the acceptable load allocation during such conditions.

5.2.3 Seasonality and Margin of Safety

All TMDL/Water Quality Restoration Planning documents must consider the influence of seasonal variability on water quality impairment conditions, maximum allowable pollutant loads (TMDLs), and load allocations. TMDL development must also incorporate a margin safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section addresses considerations of seasonality and a margin of safety in the Boulder River watershed metals TMDL development process.

5.2.3.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. Seasonality was considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. As with most metals TMDLs, seasonality is critical due to varying metals loading pathways and varying water hardness during high and low flow conditions. Loading pathways associated with overland flow and erosion of metals-contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with ground water transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or baseflow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals impairment and loading conditions are evaluated for both high flow and low flow conditions.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target compliance developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions.

5.2.3.2 Margin of Safety

A margin of safety is applied implicitly by using conservative assumptions throughout the TMDL development process (U.S. EPA, 1999). This implicit margin of safety is addressed in several ways as part of this document:

- Compliance with targets, refinement of load allocations, and, in some cases, impairment determinations are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.
- The numeric water quality standards used as a basis for water quality targets in this TMDL include built-in margins of safety to assure protection of beneficial uses.
- The most protective numeric standard (the chronic aquatic life support standard) is used as a water quality target.
- Sediment metals concentration criteria were used as secondary indicators.
- A portion of the wasteload allocation is maintained for future point sources.

5.3 Monitoring Strategy

Refer to Section 4.5.5 for a framework monitoring strategy.

5.4 Restoration Strategy

This section outlines strategies for addressing metals loading sources in need of restoration activities within Boulder River watershed. The restoration strategies focus on regulatory mechanisms and/or programs applicable to the controllable source types present within the watershed, which for the most part are associated with historic mining and mining legacy issues.

Potential metals loading sources include abandoned mining disturbances: discharging mine adits and mine waste materials on-site and in-channel. Following is a discussion of general restoration programs and funding mechanisms that may be applicable to these sources. The need for further characterization of impairment conditions and loading sources in the Boulder River is addressed through the framework monitoring plan in Section 4.5.5.

5.4.1 General Restoration & Remediation Funding Options

A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from nonpoint sources of pollution. Nonpoint sources of pollution, particularly historic mines and associated disturbances, constitute a source of metals loading to the Boulder River an Basin Creek.. Some regulatory programs and approaches considered most applicable to Prospect Creek watershed include:

- The State of Montana Mine Waste Cleanup Bureau's Abandoned Mine Lands (AML) Reclamation Program
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA) which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA).

Montana Mine Waste Cleanup Bureau Abandoned Mine Reclamation Program
The Montana Department of Environmental Quality's Mine Waste Cleanup Bureau (MWCB), part of the MDEQ Remediation Division, is responsible for reclamation of historical mining disturbances associated with abandoned mines in Montana. The MWCB abandoned mine reclamation program may be a viable alternative for addressing metals loading sources in the Boulder River watershed.

The MWCB abandoned mine reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA) with SMCRA funds distributed to states by the federal government. In order to be eligible for SMCRA funding, a site must have been mined or affected by mining processes, and abandoned or inadequately reclaimed, prior to August 3, 1977 for private lands, August 28, 1974 for Forest Service administered lands, and prior to 1980 for lands administered by the U.S. Bureau of Reclamation. Furthermore, there must be no party (owner, operator, other) who may be responsible for reclamation requirements, and the site must not be located within an area designated for remedial action under the federal Superfund program or certain other programs.

Within the Boulder River TPA, the **Yager/Daisy Mine in the Independence Mining District is ranked 99th on the MDEQ priority list.**

Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)
Reclamation of historic mining-related disturbances administered by the State of Montana and not addressed under SMCRA typically are addressed through the MDEQ State Superfund or CECRA program. The CECRA program maintains a list of facilities potentially requiring response actions based on the confirmed release or substantial threat of a release of a hazardous or deleterious substance that may pose an imminent and substantial threat to public health, safety or welfare or the environment (ARM 17.55.108). Listed facilities are prioritized as maximum, high, medium or low priority or in operation and maintenance status based on the potential threat posed. Currently there are no CECRA-listed facilities in Boulder River watershed.

CECRA also encourages the implementation of voluntary cleanup activities under the Voluntary Cleanup and Redevelopment Act (VCRA), and the Controlled Allocation and Redevelopment Act (CALA). It is possible that any historic mining-related metals loading sources identified in the watershed in the future could be added to the CECRA list and addressed through CECRA, with or without the VCRA and/or CALA process. A site can be added to the CECRA list at MDEQ's initiative, or in response to a written request made by any person to the department containing the required information.

Other Programs
In addition to the programs discussed above, other funding may be available for water quality restoration activities. These sources may include the yearly RIT/RDG grant program or the EPA Section 319 Nonpoint Source yearly grant program. The RIT/RDG program can provide up to $300,000 to address environmental related issues. This money can be applied to sites included on the MWCB's AML priority list but of low enough priority where cleanup under AML is uncertain (possibly the Yager/Daisy site). RIT/RDG program funds can also be used for conducting site assessment/characterization activities such as identifying specific sources of water quality impairment.

Section 319 grant funds are typically used to help identify, prioritize, and implement water quality protection projects with focus on TMDL development and implementation of nonpoint source projects. Individual contracts under the yearly grant typically range from $20,000 to $150,000, with a 25% or more match requirement. RIT/RDG and 319 projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county.

5.4.2 General Restoration & Remediation Priorities

The source characterization and assessment performed for this study identified abandoned mining sites associated the Independence Mining District located in the headwaters of the Boulder River watershed. It is possible that these apparent sources constitute a significant portion of the metals loading sources in the drainage area. Efforts should focus on reclamation of these identified sources following more detailed site characterization as outlined in the Monitoring Strategy (Section 4.5.5). Detailed surface water sampling should be initiated when feasible to better quantify metals loading rates and mechanisms from this area. Additional information in the form of stream sediment chemistry and mine waste physical and chemical characteristics should be obtained so that reclamation planning can be pursued as soon as feasible.

5.5 Adaptive Management Strategy

The water quality restoration targets and associated metals TMDLs developed for the Boulder River are based on future compliance with the B-1 classification water quality standards. In order to achieve compliance, all significant sources of metal loading must be addressed via all reasonable conservation practices. Because of the potential for metals contributions from natural sources as well as from controllable anthropogenic sources, an adaptive management approach is adopted for all metals targets described within this document.

In previous sections, a monitoring strategy was suggested that will provide further information on source characterization, target compliance and effectiveness of restoration activities. The adaptive management strategy presented in this section describes the process for modifying the Boulder River restoration strategy when deemed necessary. As is the case with all restoration activities, this adaptive management strategy will be best accomplished through cooperation with personnel with the authority and time to make a commitment of resources and technical personnel with the ability to evaluate monitoring data and identify scientific issues accordingly.

Possible scenarios for metals identified in this plan include:

- Implementation of restoration activities resulting in full compliance with restoration targets for all parameters;
- Implementation of restoration activities fails to result in target compliance due to underperformance or ineffectiveness of restoration actions. Under this scenario the water body remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target compliance, but target compliance is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the water body may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The MDEQ Remediation Division and/or MDEQ Standards Program personnel will lead this effort within MDEQ to make determinations concerning the appropriateness of specific mine cleanup activities relative to expectations for mining cleanup efforts for any impairment condition associated with mining impacts. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities. Where NPDES permitted point sources are involved, the MDEQ Permitting Program will also be involved. MDEQ TMDL program personnel will need to be involved in adaptive management to make sure there is consistency in water quality restoration goals as they apply to beneficial use support. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available in-stream data to reevaluate impairment determinations. The information will also help determine any further cleanup/load reduction needs for any applicable water body and will ultimately help determine the success of water quality restoration. Other stakeholders, including opportunities for public comment, will also be involved as required under applicable regulations. Public involvement is discussed further in Section 6.

SECTION 7.0
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